Duwamish/Diagonal Sampling and Analysis Plan

Pre-Phase II Addendum

Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
by the
King County Department of Metropolitan Services

November 1995

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DUWAMISH/DIAGONAL SAMPLING AND ANALYSIS PLAN ADDENDUM

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1 PRE-PHASE II STUDY DESIGN

1.1 OVERVIEW

The Elliott Bay/Duwamish Restoration Program (EBDRP) Panel and Sediment Remediation Technical Working Group (SRTWG) are considering remedial options for sediments near three existing and one former outfall on the east bank of the Duwamish River in the vicinity of Kellogg Island. The outfalls of interest are the Diagonal Way CSO/SD, Duwamish CSO, Diagonal Avenue SD and an abandoned outfall once connected to a sewage treatment plant east of the river. The King County Department of Metropolitan Services (Metro) is conducting the investigation with oversight from the EBDRP Panel and SRTWG. Duwamish/Diagonal was included in an initial investigation of 24 sites on the Duwamish River in 1992. In 1993 the site was chosen for further investigation, and in 1994 Phase I of a cleanup study was conducted. The following documents describe the investigation to date:

Concept Document, June 1994;
: Description of initial investigation and ranking procedure

Duwamish/Diagonal Cleanup Study Workplan, June 1994;
: Site characterization, source investigation, site investigation plan, approach for alternatives assessment

Duwamish/Diagonal Sampling and Analysis Plan, September 1994;
: Site investigation study design, description of field procedures and analytical methods

Duwamish/Diagonal and Norfolk Health and Safety Plan, August 1994;
: Description of equipment and procedures to minimize health and safety risks during sampling described in *Sampling and Analysis Plan*

Duwamish/Diagonal Cleanup Study Phase I Results, April 1995
: Description of the spatial extent and magnitude of sediment contamination at the site, as determined by the results of 1992 and 1994 sampling efforts.

The Phase I sampling effort identified several compounds that will be chemicals of concern (EBDRP, 1995). Phase I did not determine the boundaries of the site, shoreline and habitat features, the depth of contamination, or disposal alternatives. To address these outstanding issues, Phase II sampling is expected to occur in April or May of 1996. However, the SRTWG decided that more information was necessary to effectively design the Phase II sampling effort. This *Sampling and Analysis Plan Addendum* describes new sampling stations, field methods and analytical procedures that will be implemented during

a November 1995 Pre-Phase II sampling. Many of the Pre-Phase II methods and analyses will not differ from Phase I methods and analyses, so the *Duwamish/Diagonal Sampling and Analysis Plan* must be used as a companion document.

The primary purpose of the Phase II sampling effort is to better define the chemical distribution of certain analytes. This information will then be used to focus the Phase II sampling, and reduce the likelihood for "Phase III" work.

The criteria for determining site boundaries are provided by the Sediment Management Standards (WAC 173-204), and are known as the Sediment Quality Standards (SQS) and Cleanup Screening Level (CSL).

1.2 SUMMARY OF CHANGES FROM DUWAMISH/DIAGONAL SAMPLING AND ANALYSIS PLAN

This *Addendum* describes the new stations, tests and procedures that will be used in Pre-Phase II of the cleanup study. Some Phase I tests will not be run, as noted below. Two new analyses will be conducted.

Surface grab samples will be collected from ten new stations and two former stations. All twelve stations are outside of or on the perimeter of the area studied earlier. It is not anticipated that these stations will precisely define the boundaries of the site. Instead, it is expected that these stations will help focus the Phase II sampling, possibly eliminate some chemical compounds from consideration because of their association with other sources, and address the potential for toxicity from non-SMS criteria such as ammonia and sulfides.

The new and to-be-reoccupied grab sample stations are marked by an "■" and labeled on figure 1 on page 4. The Phase I stations are marked by a faded "X". The figure 1 bathymetry is from a June 1995 Army Corps of Engineers survey of the shoal. As in Phase I, the top 10 cm of sediment will be collected from the grab samples. Figure 2 on page 5 provides more detailed bathymetry of the area in the immediate vicinity of the outfalls and Phase I station locations.

Sediment cores will not be collected at this time. It is likely that several cores will be collected during Phase II.

Chemistry and toxicity (bioassay) tests were performed on sediment grab samples in Phase I of the cleanup study. The toxicity test results were rejected by the Washington Department of Ecology because the Puget Sound Estuary Program (PSEP) protocols were not adhered to. Toxicity tests will not be included in the Pre-Phase II sampling effort. Toxicity tests may be used in Phase II.

Tests that accompanied the toxicity tests performed in phase I will <u>not</u> be performed. These tests are;

- the field determination of pH, Eh, temperature and screening of particle size.

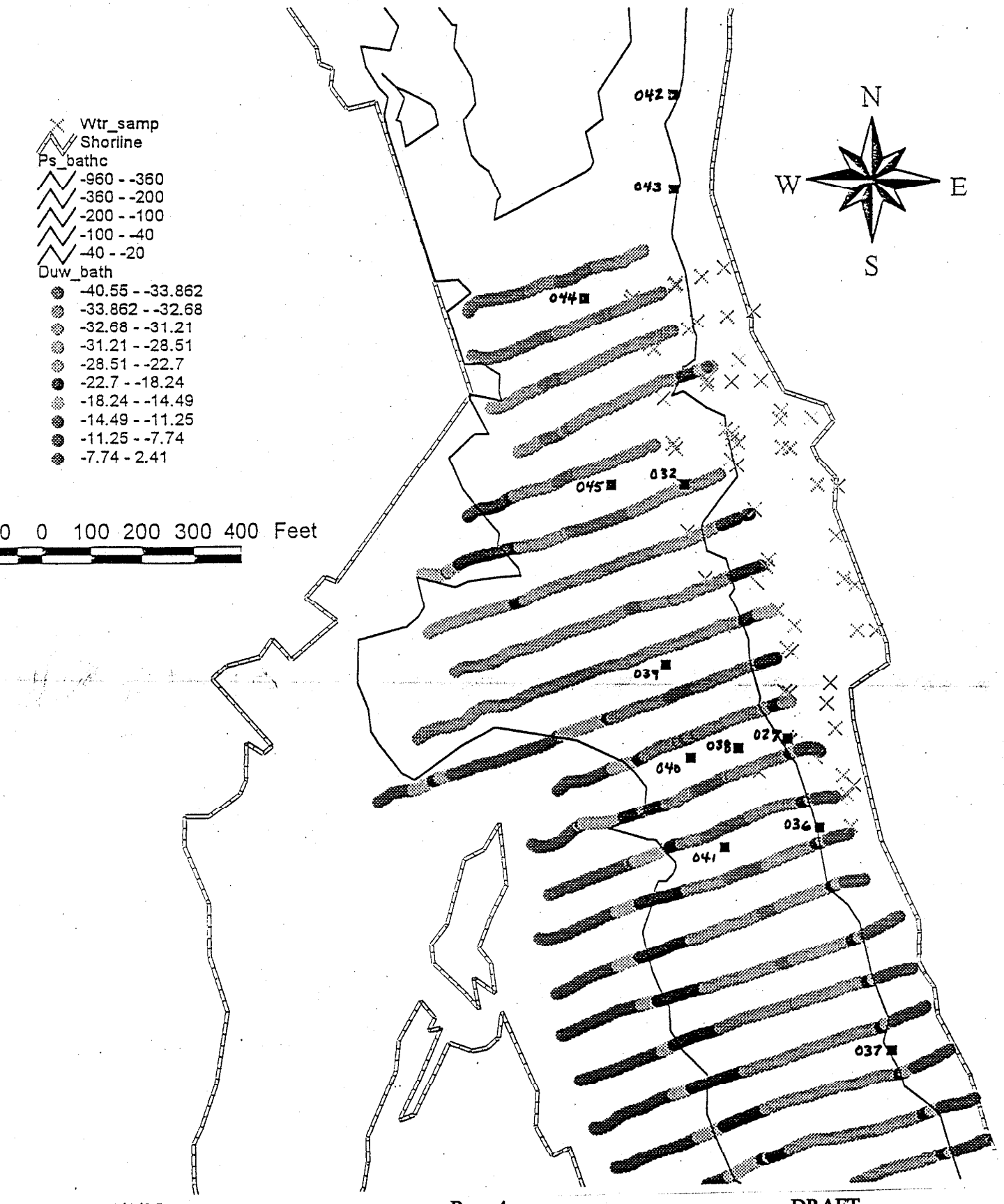
- the laboratory tests for interstitial salinity and methyl mercury.

Two new tests, ammonia nitrogen and total sulfides, will be performed. The sediments were not analzyed for ammonia and total sulfides during Phase I, although similar analyses were performed on the laboratory water during toxicity testing.

An additional sample of sediment for polychorinated biphenyl (PCB) congeners will be collected and frozen for possible analysis with Phase II samples. The analytical method will be described in the Phase II sampling addendum.

Disposal option analyses such as Toxicity Characteristic Leaching Procedure (TCLP), Total Petroleum Hydrocarbons (TPH) and Ignitability/Reactivity/Corrossivity are not being examined at this time.

Duwamish/Diagonal Pre-Phase II Sampling Locations and COE bathymetry



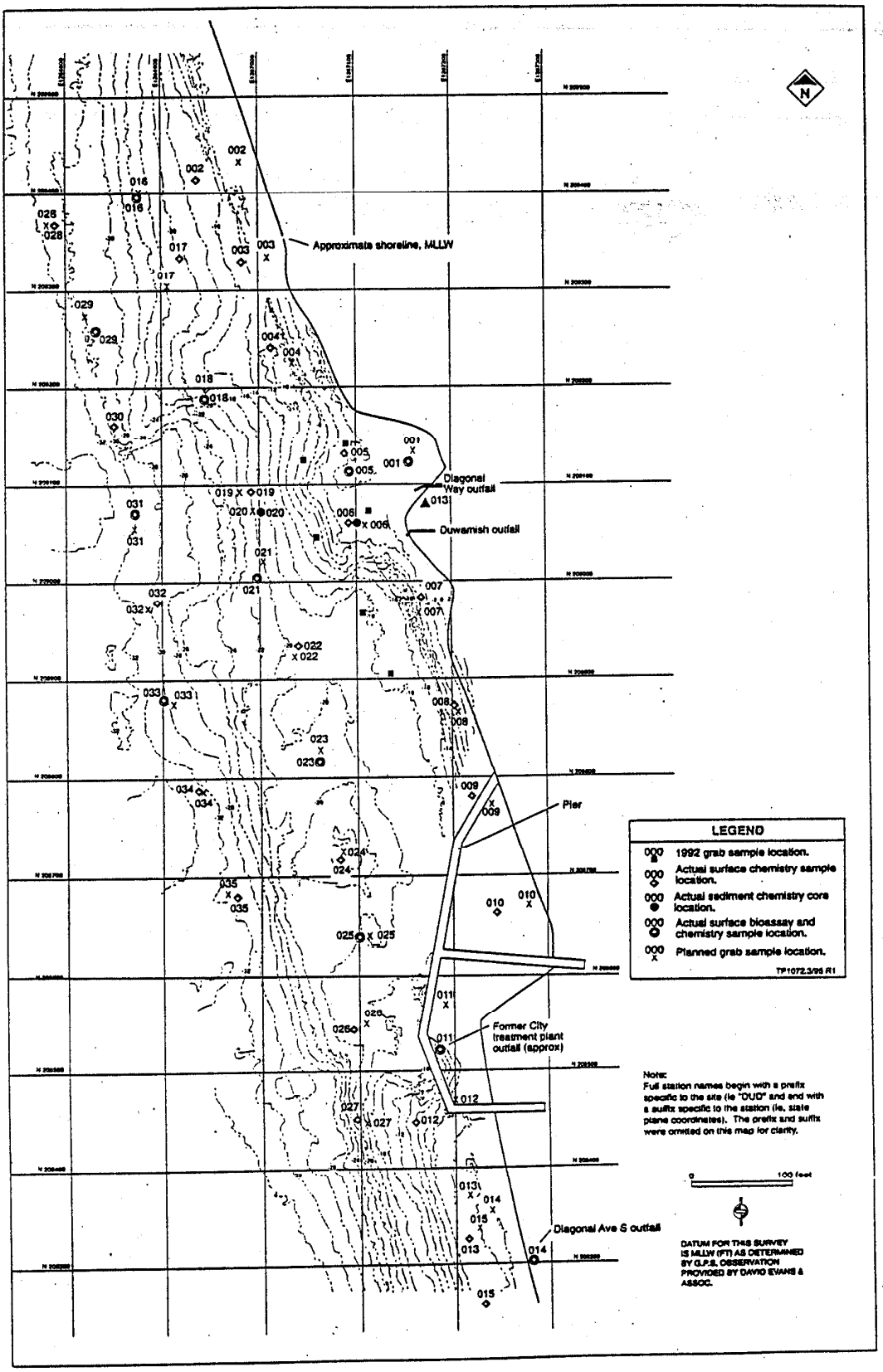


Figure 1. DUD Duwamish/Diagonal Sediment Sampling Locations and Bathymetry Contours Showing Planned and Actual Sediment Sampling Locations.

DRAFT

2 FIELD PROCEDURES

This section adds to and replaces parts of Section 3, Study Design and Section 4, Field Procedures of the *Duwamish/Diagonal Sampling and Analysis Plan.*

The Pre-Phase II sampling effort will follow most of the procedures described in the *Duwamish/Diagonal Sampling and Analysis Plan* and used in the Phase I sampling effort. The most substantial changes are;

1) modifying the systematic-stratified sampling design,
2) not collecting samples for interstitial salinity, methyl mercury and toxicity analyses,
3) not collecting field data for pH, Eh, temperature and particle size,
4) adding the collection of samples for ammonia nitrogen, total sulfides and PCB congeners,
5) determining the actual location of stations in the field based on depth and proximity criteria instead of using predetermined locations.

2.1 SURFACE CHEMISTRY STATION LOCATIONS

Site boundaries based on the Sediment Management Standards could not be determined from the Phase I sampling effort. High concentrations of several compounds, especially PCB's, tributyltin and metals, were found on the perimeter of the Phase I study. Information about the extent and composition of chemicals distant from the outfalls is desired to help design the Phase II sampling effort. Figure 1 on page 4 illustrates the following locations.

TABLE 1. DUWAMISH/DIAGONAL PRE-PHASE II SAMPLING LOCATIONS

Existing station	Planning name	Metro name	Northing	Easting	Depth Criteria	Comments
No	A	DUD042	209800	1266870	24 feet	400 ft downstream of 016 at similar depth (10-25 ft)
No	B	DUD043	209600	1266870	24 feet	200 ft downstream of 016 at similar depth (10-25 ft)
Yes	C	DUD032	208980	1266890	28-30 feet	on shoal, may be slightly offshore of earlier location
No	D	DUD045	208980	1266740	33 feet	150 feet west of DUD032
No	E	DUD039	208605	1266850	33 feet	200 ft northwest of H
Yes	F	DUD027	208450	1267100	10-25 feet	earlier location at depth of approx. 18 - 20 feet
No	G	DUD038	208430	1267000	28-33 feet	100 feet offshore of 027
No	H	DUD040	208410	1266900	33-40 feet	200 feet offshore of 027

No	I	DUD036	208260	1267165	20 feet	200 ft upstream of 027, similar depth (10-25ft strata)
No	J	DUD041	208220	1266970	33-40 feet	200 ft offshore of I, 200 ft upstream of H, same depth as H
No	K	DUD037	207790	1267310	20 feet	700 feet upstream of 027, similar depth (10-25 ft strata)
No	L	DUD044	209375	1266685	32-34 feet	100 feet west of 028

Stations 032 and 038 were chosen for field replicates. The necessity of each station was chosen based on the rationale described in Table 2.

TABLE 2 STATION LOCATION RATIONALE

Planning Name	Metro name	Rationale
A	DUD042	determine downstream extent of PCB/TBT and phthalate contamination with respect to outfall and salinity wedge
B	DUD043	same as 042, placed between 042 and downstream Phase I stations
C	DUD032	examine concentrations at or near shoal Verify chemical results at 032
D	DUD045	provides more complete information concerning distribution of chemicals in waterway
E	DUD039	similar to D except provides information on contaminants in waterway north of the south hotspot
F	DUD027	verification of high concentrations at 027, which may be downstream of chemical plume from former City treatment plant or an otherwise depositional area. Phase I sampling detected nine SMS exceedances
G	DUD038	define chemical conditions offshore of 027, part of new transect 027-038-040
H	DUD040	similar to 038, located in center of channel completes transect
I	DUD036	define chemical conditons upstream of site and 027 hotspot
J	DUD041	define conditions upstream and offshore of 027
K	DUD037	define conditions upstream and far off-site
L	DUD044	provides information on chemicals downtream and offshore of outfalls in center of channel

All of the stations are outside or on the perimeter of the original systematic-stratified sampling plan. The original study area has been divided into two units for planning purposes and because different characteristics were observed in the south, upstream portion of the original study area. Although the division of the site into two areas must remain flexible until new information is obtained, for now the site can be divided into areas roughly described by the following; a line extending offshore at approximately 290 degrees from a point on the east bank of the river at approximately N208600 and E1267300.

Stations 032 and 042 through 045 are intended to be extensions of the original systematic-stratified grid. These stations are on the north portion of the Pre-Phase II study area. The north portion was studied extensively in Phase I, so it makes sense to continue with the systematic-stratified approach. The systematic-stratified approach was based on four depth strata and 100 foot (33 m) intervals. In Phase I the fourth depth strata was 'the area deeper than -25 ft. (8 m) and to the east edge of the dredged channel.' The navigation

channel is defined by the Army Corps of Engineers and delineated by straight lines parallel to shore. The channel is roughly 250 feet from the east bank at the north edge of the study area, and about 275 feet from the east bank in the cove in the vicinity of the outfalls. The navigation channel is supposed to be maintained at a depth of -30 feet but a shoal has developed in the study area. The Phase I samples collected in this strata were at depths between 28 and 32 feet. According to the COE bathymetry, depths in the navigation channel range from 26 to 35 feet. Based on this new information, it appears that some of the Phase I samples were slightly westward of the line delineating the unmaintained area from the navigation channel. For future sampling efforts, the following strata will be used:

1) A small intertidal mudflat northeast of the Diagonal outfall,
2) The area between 0ft (MLLW) and -10 ft. (0-3m),
3) The area between -10 ft and -25 ft. (3m to 7.5m),
4) The area between -25 ft. and -30 ft. (7.5m to 9m)
5) The area deeper than -30 ft. (9m)

Stations 027 and 036 through 041 are part of a new grid to survey the area in the vicinity of the former treatment plant outfall and Diagonal Way S outfall, the southern subdivision. At present, the southern study area will be sampled on a systematic grid. Depth will be of concern only for stations 036 and 037, which need to be at the same depth as 027 (-20 feet). The depth criteria provided in Table 1 for stations 038 through 041 are recommended depths. Depth strata may be used in Phase II after another bathymetry survey has been conducted. It should be noted that the southern area is steeper than the north area. The -20 ft depth contour is approximately 110 feet from shore, as compared to 250 feet or more from shore in the north study area.

2.2 SURFACE SEDIMENT CHEMISTRY TESTS

The following tests will be conducted on all sediment grab samples, accompanied by brief descriptions of the reason for the specific test;

Conventionals

- Water soluble ammonia nitrogen (NH_3); Includes ammonia in interstitial water as well as any ammonia in a collodial form in the sediment itself which may be readily soluble in water. May cause toxicity in organisms.
- Total sulfides (TS); Toxic and unaesthetic
- Acid volatile sulfides (AVS); Related to the toxicity of metals
- Percent solids (%S); Used to convert wet-weight values from chemistry analyses to dry-weight.
- Total Organic Carbon (TOC); Convert dry-weight values of nonpolar, nonionizable organics to organic-carbon normalized values for comparison to SMS. TOC affects bioavailability of these organic compounds.
- Particle Size Distribution (PSD); Physical characteristic influencing chemical and biological variables.

Metals

- Arsenic, cadmium, chromium, copper, lead, mercury, silver, zinc; Pollutants required by SMS.
- Alumimum, antimony, beryllium, iron, nickel, selenium, thallium; Toxicity and uniformity relative to crustal elements.

Organic Compounds

- Extractable base/neutral/acid compounds (BNAs); Pollutants required by SMS.
- Chlorinated benzenes; Part of BNA list, additional analyses to lower detection limits for specified compounds.
- Polychlorinated biphenyls; Pollutants required by SMS.
- Polychlorinated biphenyl congeners; A sample will be collected but not analyzed until Phase II. Assessment of congeners may be useful for source control and risk assessment.
- Butyltins; mono-, di-, tri- and tetrabutyltins. Organotins that have been detected at elevated levels in the area. May cause toxicity.

Field acquisition of pH, Eh, temperature and particle size data and laboratory analysis of interstitial salinity and methyl mercury is meant to accompany toxicity analyses, which are not being conducted during Pre-Phase II. Ammonia nitrogen and total sulfides are parameters for which no information exists at this site yet may have substantial effects on toxicity in Phase II. The SRTWG decided to analyze for these parameters in Pre-Phase II simply to give information for planning purposes.

2.3 SURFACE CHARACTERIZATION

The procedures and documentation described in the *Duwamish/Diagonal Sampling and Analysis Plan* remain unchanged for subsections Sampler Deployment, Sample Acceptability Criteria, and Sample Documentation. Changes to the other subsections are described below.

The selection of surface sediment chemistry stations is described above. Refer to table 1 on page 6 for station coordinates and other criteria. Samples are collected with a 0.1-m^2 van Veen grab. No intertidal samples are planned for Pre-Phase II so all stations will be accessed by vessel. A 10-cm deep subsample from the center of the grab sample is taken for analysis. The samples for sulfides taken from the first grab should also be to a depth of 10-cm. Performing the analyses on composite samples, instead of individual discrete samples, is a generally accepted way of reducing field variability. Field replicates are collected and processed in the same manner. Field replicates are useful for determining total sample variability (analytical variability plus field variability).

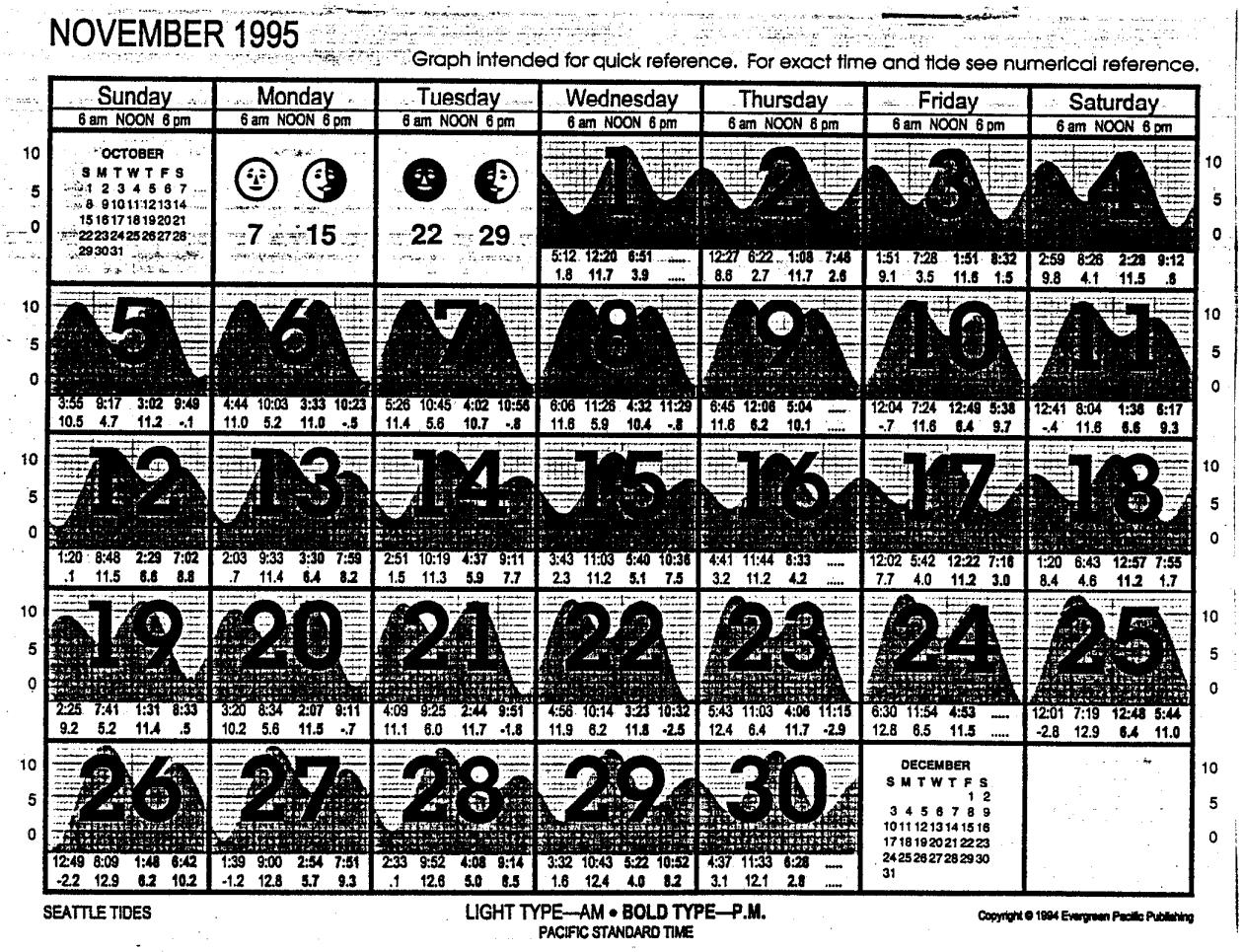
Positioning

The same general methods of positioning will be used. The only change is that a tide gauge will not be installed.

Tide data will be estimated using the attached tide chart. Corrections are not necessary, as the nearest station (Lockheed on Harbor Island) differs by only 1 minute and no height change.

The general tide chart below is for the month of November 1996, when sampling will occur. This chart provides a general guide of tide conditions and is useful for planning and sampling.

Tide chart provided with the permission of Evergreen Pacific Publishing



NOVEMBER 1995

Graph intended for quick reference. For exact time and tide see numerical reference.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6 am NOON 6 pm	6 am NOON 6 pm	6 am NOON 6 pm	6 am NOON 6 pm	6 am NOON 6 pm	6 am NOON 6 pm	6 am NOON 6 pm
OCTOBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	7 15	22 29	1 5:12 12:20 6:51 ..... 1.8 11.7 3.9	2 12:27 6:22 1:08 7:48 8.6 2.7 11.7 2.6	3 1:51 7:28 1:51 8:32 9.1 3.5 11.6 1.5	4 2:59 8:26 2:28 9:12 9.8 4.1 11.5 .6
5 3:55 9:17 3:02 9:49 10.5 4.7 11.2 -.1	6 4:44 10:03 3:33 10:23 11.0 5.2 11.0 -.5	7 5:26 10:45 4:02 10:56 11.4 5.6 10.7 -.8	8 6:06 11:26 4:32 11:29 11.6 5.9 10.4 -.8	9 6:45 12:06 5:04 ..... 11.6 6.2 10.1	10 12:04 7:24 12:49 5:38 -.7 11.6 6.4 9.7	11 12:41 8:04 1:38 6:17 -.4 11.6 6.6 9.3
12 1:20 8:48 2:29 7:02 .1 11.5 6.6 8.8	13 2:03 9:33 3:30 7:59 .7 11.4 6.4 8.2	14 2:51 10:19 4:37 9:11 1.5 11.3 5.9 7.7	15 3:43 11:03 5:40 10:36 2.3 11.2 5.1 7.5	16 4:41 11:44 6:33 ..... 3.2 11.2 4.2	17 12:02 5:42 12:22 7:16 7.7 4.0 11.2 3.0	18 1:20 6:43 12:57 7:55 8.4 4.6 11.2 1.7
19 2:25 7:41 1:31 8:33 9.2 5.2 11.4 .5	20 3:20 8:34 2:07 9:11 10.2 5.6 11.5 -.7	21 4:09 9:25 2:44 9:51 11.1 6.0 11.7 -1.8	22 4:56 10:14 3:23 10:32 11.9 6.2 11.8 -2.5	23 5:43 11:03 4:06 11:15 12.4 6.4 11.7 -2.9	24 6:30 11:54 4:53 ..... 12.8 6.5 11.5	25 12:01 7:19 12:48 5:44 -2.8 12.9 6.4 11.0
26 12:49 8:09 1:48 6:42 -2.2 12.9 6.2 10.2	27 1:39 9:00 2:54 7:51 -1.2 12.8 5.7 9.3	28 2:33 9:52 4:08 9:14 .1 12.6 5.0 8.5	29 3:32 10:43 5:22 10:52 1.6 12.4 4.0 8.2	30 4:37 11:33 6:28 ..... 3.1 12.1 2.8	DECEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	

SEATTLE TIDES

LIGHT TYPE—AM • **BOLD TYPE—P.M.**
PACIFIC STANDARD TIME

Sample Containers

Toxicity and most associated analyses are not being conducted so only two van Veen samples will be necessary for all stations. The analyses being conducted for the surface characterization require 2.4 liters of sediment. A 0.1-m^2 van Veen sampler captures approximately 5 liters. Two van Veen samples are collected and composited to reduce field variability and lessen the potential for contamination from contact with the sampler edges.

Samples that will be frozen require a headspace of up to ¼ the container volume. The volume listed below is the volume of the sample container. Allowances have been made for headspace. In all cases, the amount of sediment requested is more than required for analysis and quality control purposes. The extra sediment will be archived in case the analysis needs to be repeated.

Table 3 lists the parameters, preferred storage conditions, container volume and type. Freezing of samples will not be possible in the field, so all samples will be stored in ice chests with ice until delivered to the laboratory at the end of the day.

TABLE 3: SEDIMENT CONTAINERS AND STORAGE CONDITIONS FOR SURFACE SEDIMENTS

Parameter	Storage conditions	Container Volume	Container type
Total sulfides	Zinc acetate, dark, 4°c	250 ml	Polyethylene, amber
Acid volatile sulfides	Dark, 4°c	250 ml	Polyethylene, amber
Metals	Freeze, -18°c	100 ml	Polyethylene
Mercury	Freeze, -18°c	From metals container	Polyethylene
BNA Organics	Freeze, -18°c	500 ml	Glass/teflon lid
Chlorobenzenes	Freeze, -18°c	125 ml	Glass/teflon lid
Butyltins	Freeze, -18°c	250 ml	Glass/teflon lid
PCB congeners	Freeze, -18°c	250 ml	Glass/teflon lid
% Solids & TOC	Freeze, -18°c	125 ml	Glass
Ammonia nitrogen	Freeze, -18°c	From % Solids/TOC	Glass
PSD	4°c	500 ml	Glass

Sample Processing

This section is revised and included in its entirety because it has changed considerably due to the parameters being analyzed for.

All containers that will be refrigerated (total sulfides, acid volatile sulfides, PSD) should be filled so there is no headspace. A headspace of up to ¼ the volume of the container is allowed for samples to be frozen so that water can expand without compromising the container. Sediment grab samples are processed according to the following step-by-step procedure;

1. Bring the grab sampler aboard, place in a plastic tub and inspect for sample acceptability through the top flaps. Measure penetration depth by pushing a ruler through the sediment at the edge of the grab near the center. Record depth on the fieldsheet and Sample Notes.

2. If the sample is acceptable, slowly siphon off the overlying water from near the edges of the sampler.

3. Note the physical characteristics (texture, color, oil sheen, etc.) on the Sampling Notes and in code under Sediment Type on the fieldsheet.

4. Unwrap previously cleaned stainless steel spatulas and spoons.

5. Using a stainless steel spoon, remove a portion of sediment 10-cm deep through the flaps from near the center of the sampler. Keep the sample as undisturbed as possible. Transfer to the Total Sulfides polyethylene container. Using an eydropper, cover the surface of the contained sediment with 2 N zinc acetate solution. Cap the container and invert repeatedly to mix the sediment with solution. Store in ice chest.

6. Using a spoon, remove a portion of sediment 10-cm deep through the flaps from near the center of the sampler. Keep the sample as undisturbed as possible. Transfer to the Acid Volatile Sulfides polyethylene container. Leave no headspace and cap the container. Store in ice chest.

7. Using a stainless steel spoon, remove the top 10 cm of sample from the center of the sample, being careful to exclude sediment in contact with the edges or bottom and to avoid bumping the sides or top with sediment. Remove an area measuring approximately 10 cm by 15 cm to a depth of 10 cm. Transfer sediment to a clean stainless steel bowl and cover with aluminum foil.

8. Deploy grab sampler and repeat steps 1, 2, 3, and 7.

9. Stir the composite sample with a stainless steel spoon until the sample is of uniform color and texture. If material (e.g. twigs, leaves, shells, rocks) needs to be removed it should be noted on the fieldsheet and sampling notes.

10. Use a stainless steel spatula or spoon to fill (leave headspace) a 100 ml polyethylene container for metals analysis. Screw cap on tightly and place in ice chest.

11. Use a stainless steel utensil to fill (leave headspace) a 500 ml glass jar for BNA/Pesticides/PCB's analyses. Screw cap on tightly and place in ice chest.

12. Use a stainless steel utensil to fill (leave headspace) a 125 ml glass jar for chlorinated benzenes, filling with approximately 100 ml of sediment. Screw cap on tightly and place in ice chest.

13. Use a stainless steel utensil to fill (leave headspace) a 250 ml glass jar for butyltins. Screw cap on tightly and place in ice chest.

14. Use a stainless steel utensil to fill (leave headspace) a 250 ml glass jar for PCB congeners. Screw cap on tightly and place in ice chest.

15. Use a stainless steel utensil to fill (leave headspace) a 125 ml glass jar for analysis of percent solids, total organic carbon and ammonia nitrogen. Screw cap on tightly and place in ice chest.

16. Use a stainless steel utensil to fill a one liter 500 ml glass jar for particle size distribution characterization. Screw cap on tightly and place in ice chest.

17. When these tasks are completed at a station, discard of utensils in a container to be taken back to the laboratory for thorough cleaning.

18. Seal each glass container into a plastic baggy to prevent contamination of other samples if the container breaks. Pack samples to minimize the chances of breaking. Decontaminate the grab sampler and move to the next station.

19. All forms should accompany samples when transported.

20. Excess sediment from the grabs and composite will be placed in a 5 gallon bucket until sampling in an area is complete and then will be dumped back onto site. If a sheen is visible the excess sediment will be covered and transported back to the laboratory for disposal. Note: the excess sediment will be disposed of after analysis. If the data indicates that the sediment should be classified as a hazardous waste, the excess sediment will be sent to a hazardous waste disposal facility. Otherwise it will be disposed of as regular waste.

Previous experience has shown that a summary of procedures is helpful when dividing a sample for multiple analyses. The following is a summary of the procedure, in large type so it can be displayed a short distance from the processing area aboard the vessel.

I. Note features and measurements

II. Portion undisturbed sample for Total Sulfides

III. Portion undisturbed sample for Acid Volatile Sulfides

IV. Transfer sample to bowl. Collect another grab.

V. Note features and measurements. Composite and mix.

VI. Metals

VII. BNA/Pest/PCB

VIII. Chlorinated Benzenes

IX. Butyltins

X. PCB congeners

XI. Ammonia nitrogen, TOC, % Solids

XII. PSD

XIII. Bag, pack, decontaminate

XIV. Complete COC, logs and sampling notes

Sampler Decontamination and Container Cleaning Procedures

The following procedure differs slightly from the *Duwamish/Diagonal Sampling and Analysis Plan.*

Sample contamination must be avoided during sample collection. All sampling equipment, sample containers, utensils, instruments, working surfaces and other items that may come in contact with the sediment should be made of a noncontaminating material (e.g., glass, stainless steel, PTFE plastic) and cleansed properly prior to use.

The van Veen grab sampler will be cleaned between sampling sites with the following procedure:

1. Soap ("detergent 8") and water scrub with a long brush
2. Thorough in-stream site water rinse.

These procedures are an exception to the Puget Sound Protocols and are implemented to avoid the use of both acetone and methylene chloride in the field. The soap and water scrub will be equally effective in removing any film of contaminants that might present a carryover problem, and will avoid three additional problems;

- The generation and handling of a flammable hazardous waste in the field.
- The difficult task of providing proper engineering controls under field conditions to avoid worker exposure to toxic chemicals.
- The possibility of contaminating samples (or the environment) with solvent.

As an added measure, when samples are drawn from the grab sampler the perimeter sections which have contacted the sides of the sampler will be excluded.

Stainless steel bowls, trays, utensils and teflon bars will be prepared at the laboratory by a detergent scrub, several rinses in RO (reverse osmosis) water, followed by an acetone rinse with a squirt bottle. They are allowed to air dry and then are wrapped in aluminum foil, which is not removed until used in the field. A clean set of sample handling equipment will be used for each core section. After use they will be placed in a covered box and returned to the laboratory for cleaning.

New sample containers from the factory will be used for parameters analyzed at the Metro laboratory. Contract laboratories will provide containers prepared by them for the specific parameter.

New disposable nitrile gloves will be provided for technicians handling samples.

3 ANALYTICAL METHODS

The analyses performed for comparison to the Sediment Management Standards were presented in the *Duwamish/Diagonal Sampling and Analysis Plan.* Some of that information is repeated here for convenience. Some analyses performed on Phase I samples will not be performed on Phase II samples. New analyses are presented in this section of the *Addendum.*

3.1 SEDIMENT CHEMISTRY ANALYTICAL PROTOCOLS

Chain of Custody

Chain of Custody records will be maintained for all samples. These records will document the following information:

- sample identification number
- date and time samples were collected, as well as name of sampler
- location and conditions of sample storage
- date and time of any transfer of possession or change in location

Samples will be transferred to subcontracting laboratories under chain of custody conditions and these conditions will be maintained throughout the analyses.

Holding Times

Holding times to be observed for this project are shown in table 4.

Hold times are based on sample storage under frozen conditions for those parameters which may be frozen. Hold times are based upon storage at 4°C for those parameters which may not be stored under frozen conditions.

TABLE 4: SAMPLE STORAGE CONDITIONS FOR SEDIMENTS

Parameter	Sample Container	Storage Conditions	Hold Time	Source of storage requirements*
Total sulfides	P	Preserved, dark, 4°c	7 days	AmTest
Acid volatile sulfides	P	Dark, 4°c	7 days	EPA, AmTest
Metals	P	freeze at -18° C	2 years to analyze	ARM
Mercury	P	freeze at -18° C	28 days to analyze	Metro
BNA	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	ARM
PCB	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	ARM
Chlorobenzenes	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	ARM
PCB congeners	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	Metro
Butyltins	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	Battelle
Percent Solids	G	freeze at -18° C	6 months to analyze	Metro
Total Organic Carbon	G	freeze at -18° C	6 months to analyze	ARM
Ammonia nitrogen	G	freeze at -18° C	6 months to analyze	Metro
Particle Size Distribution	G	refrigerate at 4° C	6 months	ARM

*AmTest = information provided by contract laboratory that will perform test
*Battelle = information provided by contract laboratory that will perform test
*ARM = Minutes of Third PSDDA *Annual Review Meeting*. This document summarizes many program/industry hold time standards. Those to be used for this project are listed above (ARM, 1991).
*EPA = Analytical Method for Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment (EPA, 1991)
*Metro = Personal communication with Scott Mickelson, Metro Environmental Laboratory
P = polyethylene, G = glass
Note: all samples to be stored frozen when allowed. Samples to be refrigerated at 4 degrees Celsius after thawing

Analytical Methodology

Analyses for most metals, organics and conventional parameters will be conducted at the Metro Environmental laboratory. Analyses for the following parameters will be conducted at subcontractor laboratories:

Subcontracted Parameter

- Particle Size Distribution
- Total Sulfides
- Acid Volatile Sulfides

- Butyltins

When applicable, methodology cited herein is approved by Ecology for the analysis of marine sediments, solid waste and soils. When applicable, these method citations includes both a preparation and instrumentation method. All Sediment Quality Standards Chemicals of Concern are contained in the Metro target lists.

Methods Described in *Duwamish/Diagonal Sampling and Analysis Plan*

All samples will be analyzed for most of the parameters studied in Phase I. The tests that will not be conducted in Pre-Phase II are interstitial salinity, methyl mercury, and the toxicity (bioassay) tests. Total sulfides and ammonia nitrogen are new analyses. A sample for PCB congeners will be collected but not analyzed. PCB congener methodology will be described in the Phase II SAP Addendum.

The methods listed in table 5 were described in the *Duwamish/Diagonal Sampling and Analysis Plan.* The analyses for metals, mercury, BNAs, PCBs, TOC, total solids, and PSD have not been modified and will not be repeated in this section. The rest of this section is devoted to describing the new and modified analyses.

TABLE 5: SUMMARY OF METHODS DESCRIBED IN THE *DUWAMISH/DIAGONAL SAP*

	SAP Page no.	SAP Table no.	Method
Metals	76	11	EPA 3050/6010
Mercury	76	11	EPA 7471
BNA	77-78	12	EPA 3550/8270
Chlorinated benzenes	79	13	EPA 3550/8270 and ion trap detector or Selected Ion Monitoring (SIM)
PCB's	80	14	EPA 3550/8080
Total Organic Carbon	81	15	SM 5310B PSEP
Total Solids	81	15	SM 2540-B
Particle Size Distribution	81	15	PSEP and ASTM 422
Acid volatile sulfides	81	15	EPA, PSEP
Tributyltin	82	16	MER

BNA = Base/Neutral/Acid extractable organic parameters

PCB = Polychlorinated biphenyls

References: APHA, 1992; ASTM, 1990; EPA, 1986; EPA 1991, PSEP 1986, MER 1989

Methods Modified Since *Duwamish/Diagonal SAP*

Chlorinated Benzenes

Due to the two-stage analysis for chlorinated benzenes described in the *Duwamish/Diagonal SAP*, extracts used to determine chlorobenzenes and related compounds by ion trap GC/MS were analyzed after the *SAP* specified extract holding time. To avoid violating holding time requirements and minimize overall turnaround time, the sediment sample for chlorinated benzenes will be extracted and analyzed by ion trap GC/MS concurrently with or immediately following the regular GC/MS analysis.

Pesticides and PCBs

Six pesticides were detected within the Phase I study area with no apparent patterns evolving. Pesticides are not required by the Sediment Management Standards. The Metro laboratory has expressed that not analyzing for pesticides would simplify the extraction process for PCBs. Pesticides will not be analyzed for at this time.

Tributyltin

Due to Metro contract procedures, a different laboratory has been selected for the tributyltin analyses. Battelle will be performing the analyses, and is accredited by the *Washington state Department of Ecology for sediment analyses. Battelle uses the same* reagents and equipment for analysis but references a different method than the laboratory used previously. Metro has not conducted a comparison of the methods. Battelle reports four butyltins compared to the two reported previously, and detection limits are substantially lower.

Butyltin analyses are performed according to SOP MSL-M-004 Analysis of Butyltins in Sediment and Tissue, following the method of Unger et al (Unger et al, 1986). Sediment samples are extracted with methylene chloride using a roller under ambient conditions followed by derivitization using a Grignard reagent to change to a form compatible with gas chromatography. *Sample extracts are then cleaned by passing through a florisil* column. Extracts are analyzed using Gas Chromatography/Flame Photometric Detection (GC/FPD). Results are calculated for mono-, di-, tri- and tetrabutyltins. Detection limits for sediments are approximately 0.5 μg/kg. Percent solids is determined on a separate aliquot.

The analysis includes analysis of a method blank, a blank spike, and a standard reference material (PACS-1). Additional QC samples such as matrix spikes and replicates are charged as additional samples.

New Methods

TABLE 6: DETECTION LIMITS OF NEW PARAMETERS

Parameter	MDL	RDL
Total Sulfides	5 mg/kg	10 mg/kg
Ammonia Nitrogen	1.0 mg/kg	2.0 mg/kg

Total Sulfides

The total sulfides procedure is conducted by AmTest, a contract laboratory accredited by the Washington state Department of Ecology for sediment analyses. *AmTest uses the* method described in PSEP 1986 which measures the acid-soluble H_2S, HS^-, and S^{2-} in a sample.

Ammonia Nitrogen

The method is designed to measure "water soluble ammonia nitrogen" which includes ammonia in interstitial water as well as any ammonia in a collodial form in the sediment itself which may be readily soluble in water. The extraction procedure is a modified version of the "ammonia nitrogen in soil" procedure referenced in "Methods Manual for Forest Soil and Plant Analysis," Forestry Canada - Northwest Region, 1991.

The extraction procedure consists of adding approximately 4 g of sediment sample to 250 ml of deionized water and shaking the slurry for approximately 3 hours. The slurry is then filtered and the resultant extract is analyzed according to SM4500-NH_3 H, the automated phenate method.

Laboratory Reports

The reporting formats and requirements and QA1 review will not change for those analyses described in the *Duwamish/Diagonal SAP*.

The butyltin report will consist of a summary table of all sample results and all associated QA/QC results. A narrative detailing the method, QA/QC results and any other information pertinent to the project will be provided. All raw data will be kept on file in the laboratory, available upon request.

Data reported from AmTest (PSD, total sulfides, acid volatile sulfides) will be accompanied by the raw data. This raw data, along with the QC data, will be used to conduct a QA1 review of the subcontracted procedures.

Data will be reported to the Metro project manager within 60 days of receipt by the laboratory. The QA1 narrative and reporting requirements are unchanged.

5.2 SEDIMENT CHEMISTRY QUALITY CONTROL

The quality control samples listed in table 7 will be analyzed to support data generation activities for this project. The type and frequency of quality control sample in table 7 is based on PSDDA and other guidelines.

Results from these quality control samples will be used to assess the data according to QA 1 guidelines. Data will then be qualified in accordance with Metro data qualifiers, as shown in Table 8.

TABLE 7: QC SAMPLE FREQUENCY FOR SEDIMENT CHEMISTRY PARAMETERS

Parameter	Blanks	Replicates	Triplicates	Matrix spike	Crm *	Surrogates
BNA	1 per batch	5% minimum, 1/extraction batch	NA	5% minimum, 1/extraction batch	1 per 50 samples	yes
PCB	1 per batch	5% minimum, 1/extraction batch	NA	5% minimum, 1/extraction batch	1 per 50 samples	yes
Metals	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Mercury	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Total Organic Carbon	1 per batch	5% minimum, 1/batch	5% minimum, 1/batch	NA	1 per batch	NA
Percent Solids	NA	5% minimum, 1/batch	5% minimum, 1/batch	NA	NA	NA
Particle Size Distribution	NA	10 % of samples	10 % of samples	NA	NA	NA
Ammonia nitrogen	1/20	1/20	NA	1/20	NA	NA
Total Sulfides	1 per batch	10 % of samples	10 % of samples	NA	NA	NA
AVS	1 per batch	10 % of samples	10 % of samples	NA	NA	NA
Butyltins	1 per batch	1 per batch	NA	1 per batch	1 per batch	NA

* Subject to availability. A check standard will be analyzed should a CRM (or certified reference material) not be available.

TABLE 7: QC SAMPLE FREQUENCY FOR SEDIMENT CHEMISTRY PARAMETERS

Parameter	Blanks	Replicates	Triplicates	Matrix spike	Crm *	Surrogates
BNA	1 per batch	5% minimum, 1/extraction batch	NA	5% minimum, 1/extraction batch	1 per 50 samples	yes
PCB	1 per batch	5% minimum, 1/extraction batch	NA	5% minimum, 1/extraction batch	1 per 50 samples	yes
Metals	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Mercury	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Total Organic Carbon	1 per batch	5% minimum, 1/batch	5% minimum, 1/batch	NA	1 per batch	NA
Percent Solids	NA	5% minimum, 1/batch	5% minimum, 1/batch	NA	NA	NA
Particle Size Distribution	NA	10 % of samples	10 % of samples	NA	NA	NA
Ammonia nitrogen	1/20	1/20	NA	1/20	NA	NA
Total Sulfides	1 per batch	10 % of samples	10 % of samples	NA	NA	NA
AVS	1 per batch	10 % of samples	10 % of samples	NA	NA	NA
Butyltins	1 per batch	1 per batch	NA	1 per batch	1 per batch	NA

* Subject to availability. A check standard will be analyzed should a CRM (or certified reference material) not be available.

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Duwamish/Diagonal Sampling And Analysis Plan

Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
by the
King County Department of Metropolitan Services

Elliott Bay/Duwamish Restoration Program
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September 1994

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1 INTRODUCTION

1.1 ELLIOTT BAY/DUWAMISH RESTORATION PROGRAM

This sampling and analysis plan (SAP) has been prepared on behalf of the Elliott Bay/Duwamish River Restoration Program (EBDRP) Panel which is composed of federal, state and tribal natural resources trustees, the King County Department of Metropolitan Services (Metro) and the City of Seattle (City). A Sediment Remediation Technical Working Group (SRTWG) was established by the EBDRP Panel to address contaminated sediment issues. The Technical Working Group identified 24 potential sediment remediation sites associated with Metro and City combined sewer overflows (CSO) and storm drains (SD). Sites were prioritized and selected based on criteria including;

- the presence of contaminants at concentrations exceeding the Sediment Management Standards of Washington State (WAC Chapter 173-204),
- adequate control of sewer overflows, storm drains and industrial discharges to prevent recontamination,
- potential for addressing injury to target species and fish,
- potential to incorporate habitat improvement or proximity to other habitat or sediment remediation sites,
- potential for human health risk,
- potential for public education projects,
- potential for coordination with other projects (EBDRP, 1993).

Of the 24 sites considered, the SRTWG selected 3 sites for further investigation based on the above criteria and public input. The sites chosen include the Duwamish Pump Station CSO, Diagonal Way CSO/SD, and Norfolk CSO (EBDRP, In Press) (figure 1). Metro's Duwamish Pump Station is near the City's Diagonal Way outfalls so these two projects were combined into one. The Norfolk CSO project is described in other documents.

1.2 PROJECT DESCRIPTION

Site Description

The Duwamish/Diagonal site is located in the lower portion of the Duwamish River waterway at approximately river kilometer 3 in south Seattle, WA (figure 2). The site is on the east bank of the river upstream of Harbor Island and immediately downstream of Kellogg Island. The City of Seattle Diagonal Way CSO/SD outfall (Diagonal) is located south of the Port of Seattle Terminal 106 at the South Oregon Street unimproved street right-of-way. This outfall is exposed at Mean Lower Low Water (MLLW). The Metro Duwamish Pump Station outfall (Duwamish) is approximately 100 ft (30 m) south of the Diagonal structure and is submerged.

Another oufall is located upstream of the site. The City of Seattle Diagonal Avenue stormdrain is located 230 m (750 ft) upstream of the Diagonal Way outfall. For the purpose of this study, the boundaries are intended to include the area impacted by the Duwamish and Diagonal Way outfalls. Two nearby areas located up stream near a former sewage treatment plant outfall and the Diagonal Avenue stormdrain are also being studied and may be included in the site if related to chemical problems in this section of the river.

Summary of Existing CSO/SD and Sediment Data

Discharges from the Duwamish Pump Station and Diagonal CSO/SD lines have not been sampled. The Duwamish Pump Station has not overflowed during the period from 1989 to the present, and therefore CSO overflows have not been sampled. Regular sampling of influent to the Duwamish Pump Station has been performed by Metro's Industrial Waste Section, but not during storm periods. The City has not sampled the Diagonal basin lines for either storm water or CSO discharge quality.

Sediment samples were collected from two sites in the Diagonal Way CSO/SD pipe during the Elliott Bay Action Program source investigation (Tetra Tech, 1988). Contaminants measured in those samples which exceeded the highest Apparent Effects Threshold (AET) included indeno(1,2,3-c,d)pyrene, chlorinated benzenes, phenol, 4-methylphenol, and dimethyl phthalate. The concentrations of 1,4-dichlorobenzene and phenol were the highest concentrations found in the study. Concentrations of indeno(1,2,3-c,d)pyrene and total phthalate also exceeded the highest AET in sediments collected from the Diagonal Avenue SD (Tetra Tech, 1988).

Sediment samples were collected from two locations in the vicinity of the outfalls in 1985 during the Elliott Bay Action Program Analysis of Toxic Problem Areas (PTI/Tetra Tech, 1988). This data is discussed in the Work Plan.

As part of the Harbor Island Remedial Investigation sediment samples were collected in the center of the Duwamish Waterway channel approximately 60 m downstream and 370 m upstream of the outfalls (Weston, 1993). Phenol, cadmium, antimony and tributyltin were identified at elevated levels. Phthalates, PAHs, mercury and silver were measured at concentrations below the Sediment Management Standards (SMS) Sediment Quality Standards (SQS).

Sediment samples were collected in October 1992 by Metro to provide preliminary screening of identified sites potentially contaminated by discharges. Six sediment samples were collected near the Duwamish and Diagonal outfalls at sampling locations shown in figure 3. Some concentrations of butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, benzoic acid, mercury and silver exceeded the SMS Cleanup Screening Levels (CSL). Dibenzo(a,h)anthracene, benzo(g,h,i)perylene and PCB's were also identified as chemicals of concern because each exceeded the SMS SQS at one station. More information is available in the Work Plan.

Purpose of the Sampling and Analysis Plan

The Sampling and Analysis Plan (SAP) is one of four parts of a Cleanup Study Plan; the other parts being a Work Plan, a Health and Safety Plan, and a Public Involvement Plan. The Cleanup Study Plan and its component parts are required by the Sediment Management Standards. These four documents were published separately and are available for review. The SAP describes in detail the field and analytical laboratory

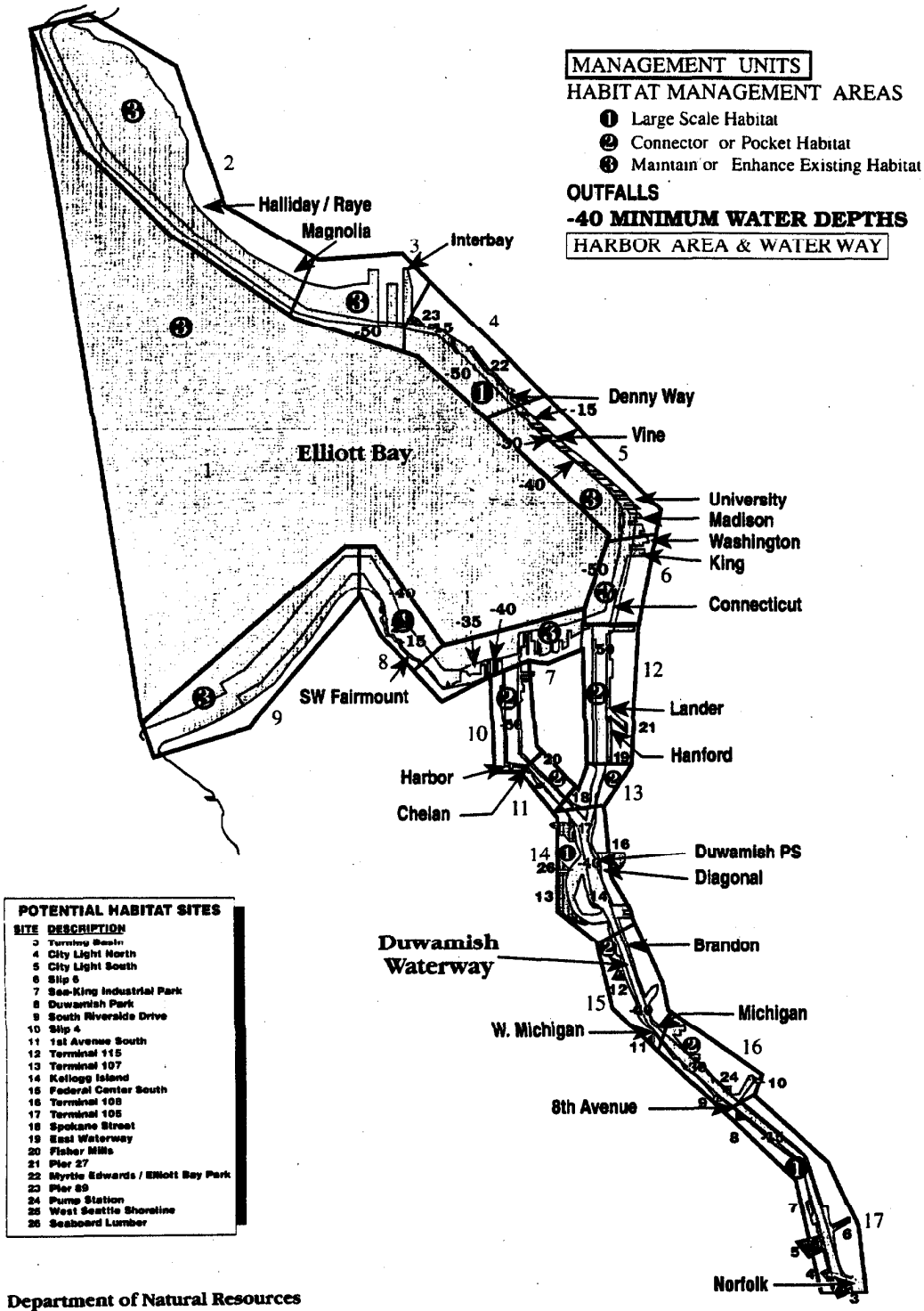
methods outlined in the Site Investigation section of the Work Plan. This SAP has been developed in accordance with the requirements of the SMS and the Sediment Cleanup Standards User Manual produced by the Washington Department of Ecology (Ecology).

The purpose of this SAP is to describe the field, laboratory, quality assurance and analytical methods that will be used to;

- characterize sediments in the river in the area suspected to be impacted by the Duwamish and Diagonal outfalls, and,
- characterize the storm water discharges from the Diagonal outfall.

Elliott Bay Co-op

Elliott Bay and Duwamish Waterway Management Units
Potential Sediment Cleanup Sites, Habitat Restoration Sites, and Navigation/Commerce Considerations



Department of Natural Resources
March, 1993

Figure 1.

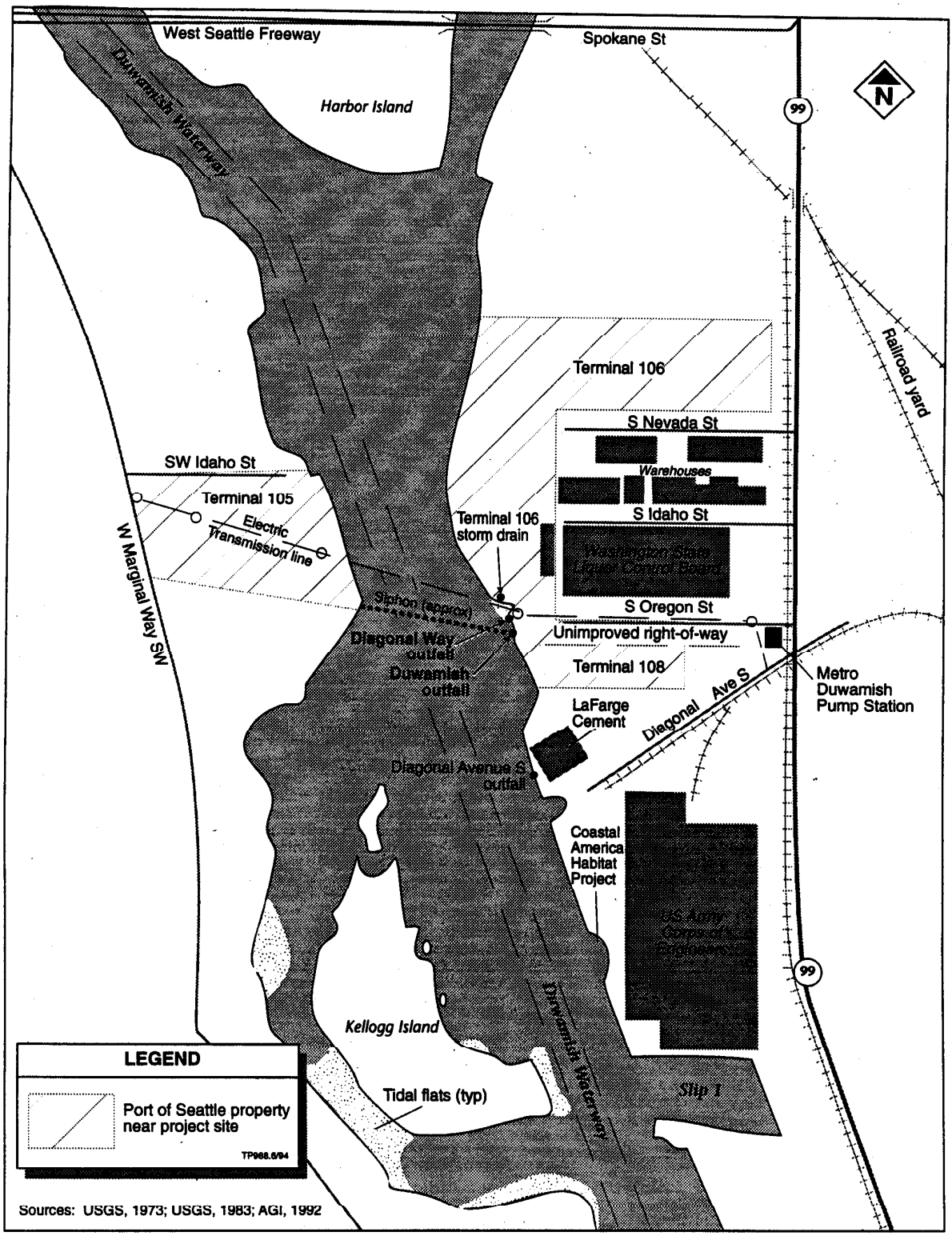


Figure 2. Duwamish/Diagonal Area Map (Current Conditions)

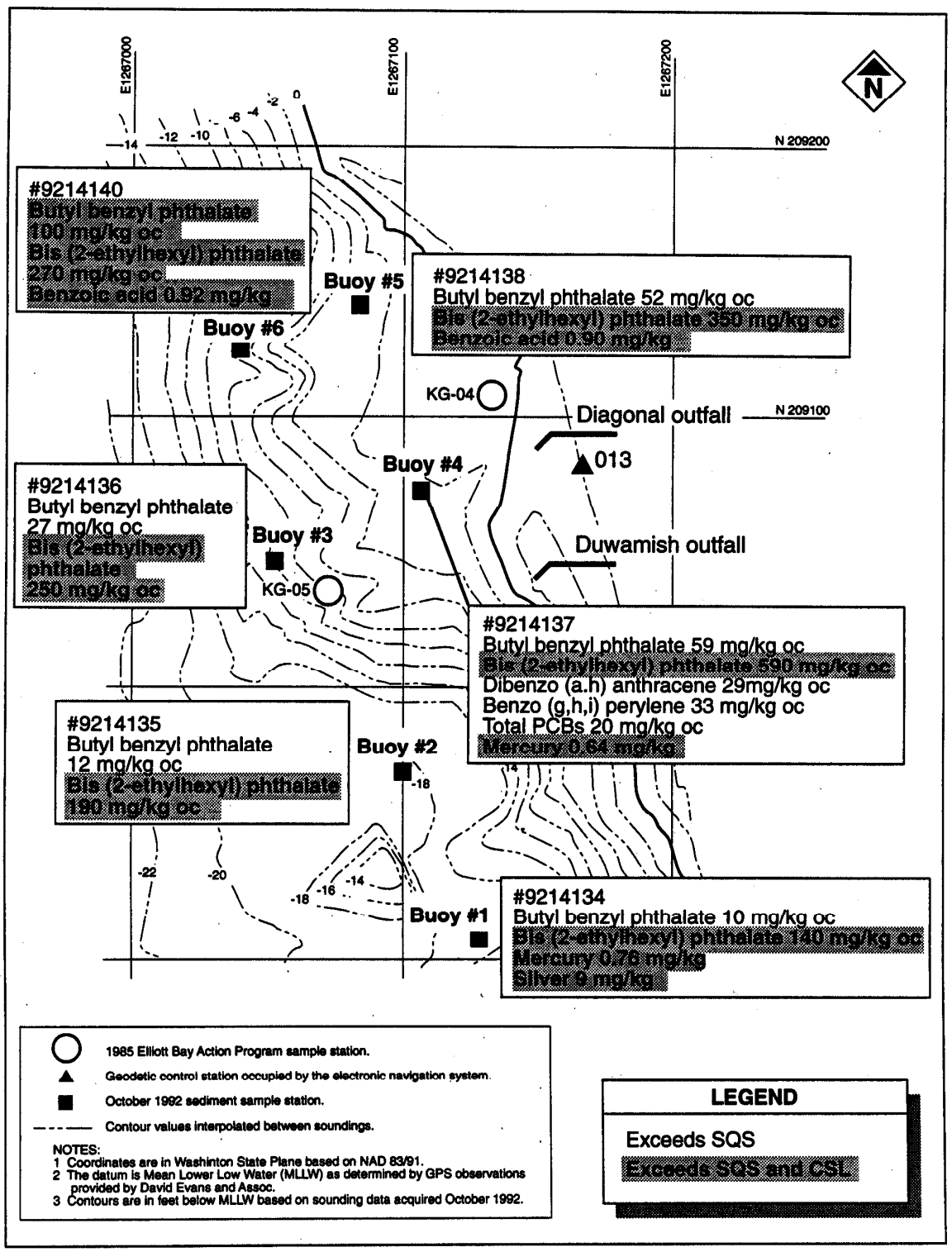


Figure 3. Historical and Preliminary Sediment Sampling at Duwamish/Diagonal

2 PROJECT MANAGEMENT

The tasks involved in conducting the Duwamish/Diagonal Cleanup Project cleanup and who will assume responsibility for each task are outlined below. The EBDRP Panel approved development of the Cleanup Study Plan by Metro and the City of Seattle with the understanding that they would carry out the project under the direction of the Panel and the Sediment Remediation Technical Working Group. Metro is proposing to be the project manager for conducting the cleanup study, alternatives investigation and cleanup implementation. When work is contracted to a consulting firm or outside laboratory, either Metro or the City of Seattle will oversee the work.

The following abbreviations are used;

- Metro - the Water Pollution Control Department of the King County Department of Metropolitan Services, formerly known as the Municipality of Metropolitan Seattle. Usually led by the Water Resources Section.
- City - City of Seattle Departments, led by the Drainage and Wastewater Utility
- NOAA - National Oceanic and Atmospheric Administration, EBDRP Panel members
- Golder Ass. - a consulting firm
- Metro ELD - Metro's Environmental Laboratory Division
- Metro IW - Metro's Industrial Waste Section
- Metro WR - Metro's Water Resources Section
- P.P. Comm - the EBDRP Panel Public Participation Committee

2.1 CLEAN UP STUDY PLAN

Document preparation	In house	Metro/City

2.2 CLEAN UP STUDY

Sediment salinity sampling	In house	NOAA/Metro
Bathymetry survey	Contract	Golder Ass. under Metro
Storm water sampling	In house	Metro ELD
Surface sediment sampling	In house	Metro ELD
Sediment chemistry analysis	In house	Metro ELD
Analysis of certain parameters	Contract	Contractors under Metro ELD
Bioassay testing	Contract	Contractor under Metro ELD
Cores for contamination depth	Contract	Contractor under Metro WR
Cores for sedimentation rate	Contract	Contractor under Metro WR
Modelling	In house	Metro/City
Pipe sediment sampling	In house	City/Metro
Source control	In house	Metro IW/City
Risk assessment	In house	Metro
Clean up study report	Contract	Contractor under Metro

2.3 ALTERNATIVE ASSESSMENT

Alternative development eval.	Contract	Contractor/City/Metro
Sediment disposal site option	In house	Metro Technical Serv.
Public participation	In house	Metro/P.P. Comm.
Alternatives assessment report	Contractor	Contractor under Metro
Permitting	In house	Metro/City
Final design	In house/Contract	Metro/City/Contractor

2.4 CLEAN UP IMPLEMENTATION

Construction contract	Contract	Contractor/Metro
Monitoring during construction	In house	Metro
Post construction monitoring	In house	Metro

3 STUDY DESIGN

3.1 OVERVIEW

The Duwamish Waterway is a complex environment in which tidal influences and river flow cause water levels, current directions, salinity, and other conditions to fluctuate. These changes may affect sediment chemistry and toxicity. The goal of the cleanup study investigation is to identify areas that exceed the Sediment Quality Standards (SQS) or Cleanup Screening Levels (CSL). It is beyond the scope and purpose of this study to evaluate the differences and changes which occur in an estuarine environment, but important factors such as salinity must be considered in the design of the investigation.

3.2 DATA GAPS AND NEW SAMPLING NEEDS

Six sediment grab samples were taken at the Duwamish/Diagonal site as part of a preliminary investigation of potential remediation sites. Contaminant concentrations measured at levels exceeding the SQS and CSL concentrations are shown in figure 3. Because high concentrations were measured in all samples, additional sediment grab sampling over a larger area is required to determine the horizontal extent of contamination.

Past and present upstream discharges have been identified which may be significant sources of contaminants in the Duwamish River. Sampling near these discharges will identify whether upstream sediments should be included in remediation efforts and what impacts the discharges and associated sediments could have downstream.

New bathymetry data extending well beyond the planned study area and encompassing the past and present discharges upstream is needed to determine station locations and help delineate shorelines and habitats.

The Harbor Island Remedial Investigation found tributyltin at elevated concentrations (above reference levels) in the waterway. The 1992 preliminary investigation at this site did not include analysis of tributyltin. Analysis of tributyltin is a part of this investigation.

Toxicity testing (bioassays) at the site have been limited to two samples collected in 1985 as part of the Elliott Bay Action Program study. Additional testing is needed to provide information that will be used to assess risks to natural resources in the waterway. Bioassay results will be particularly useful to confirm the need for cleanup where there are isolated areas of high contaminant concentrations and where the influence of the outfalls appears to be decreasing. Because the Duwamish River is different from either a marine or freshwater environment, toxicity testing will also provide information to better understand the toxicity of the sediments in an estuarine environment. Four preliminary interstitial salinity samples were collected at the stations shown in Figure 4. Interstitial salinity data is used to guide the selection of bioassay organisms. The salinity data indicated that marine species are appropriate.

Samples have not been collected to determine the depth of contamination, which is a concern because it is likely that dredging will be considered as a cleanup option and depth of contamination will be required for estimating removal volumes. Sediment chemistry cores are required to determine the vertical extent of contamination. The cores may also provide information useful for understanding patterns of contamination given the number of past potential sources and the long history of contaminant inputs.

A Source Control Decision Framework has been developed as part of the Work Plan. The Framework may require modeling of selected chemical parameters and physical processes. The models require two parameters, the rate of bulk sedimentation and the depth of the mixed layer. Sediment cores are required to obtain these parameters, which are determined by examining the concentration profiles of Lead-210 or Cesium-137. These cores will not be taken until Phase II.

We must determine whether continuing to discharge poses a risk to long term success of the cleanup. In order to run the computer models that will be key to the source control decision making process, we need to collect data on the quality of storm water in the Diagonal basin. Inspection of the Diagonal storm drain line for an accumulation of sediments will be conducted by the City of Seattle as part of a routine pipe inspection. If appreciable sediment is found, then sampling will be proposed during phase II and included as an addendum to the Sampling and Analysis Plan. The Duwamish Siphon CSO has not been known to overflow in recent years and therefore no sampling is planned.

3.3 PREPARATORY INVESTIGATIONS AND PLANNING

Bathymetry data of the entire study area and interstitial salinity samples were collected and analyzed in March and April 1994. Bathymetry data was necessary to determine station locations and will help delineate the shoreline. Interstitial salinity information was needed to determine whether marine, estuarine or freshwater organisms are used for bioassays. The methodologies for bathymetry data and interstitial salinity sampling and analysis are included in this plan although the investigations were completed before this report.

The bathymetry survey conducted in 1992 does not cover the entire area being studied. Three stations are located north of the 1992 survey area and sixteen stations are south of the 1992 survey area, down to an area around the Diagonal Avenue South outfall. Additional bathymetry data were collected in April 1994 and a revised map of sampling locations will be developed. The bathymetry data does not fully delineate the lower shoreline (MLLW) and upper shoreline (top of rip-rap wall). A field crew will map the shoreline at a tide lower than MLLW using a total station and staff gauges. A biologist may conduct a habitat survey at the same time. If necessary, suitable temporary reference points for positioning surveying equipment will be determined by this mapping effort.

Flow meters have been installed at the two manholes described below in preparation for water quality sampling of the Diagonal Way storm drain. Baseline samples were collected in late-May 1994. Starting in June 1994, attempts will be made to collect storm water quality samples.

3.4 PHASE I INVESTIGATION

Diagonal Storm Drain Water Quality

In order to run the computer models that will be key to the source control decision making process, we need to collect data on the quality of storm water in the Diagonal storm drain. Samples are to be collected at two sites in the basin: from a manhole near the Diagonal outfall and at a manhole where flows from the Hanford tunnel enter the Diagonal drainage system (figure 5). These sites were chosen to characterize the entire drainage basin with the fewest sampling locations.

Five samples from each of the stations will be collected: one sample during a period of relative dry conditions to represent "baseline" conditions and four samples during storm events. Two of the four storm samples will be collected during the "wet" season (November through April) and two of the samples will be collected during "dry" season storms (May through October). In the field, conductivity measurements will be made as part of the sample acceptance process to insure that saline river water is not in the pipe due to tidal influence. At the laboratory, samples will be analyzed for priority pollutant organics and metals, hardness, total suspended solids, and pH.

Surface Sediment Chemistry and Toxicity Station Locations

Surface sediment chemistry and toxicity (bioassay) sampling and testing are needed to determine the areal extent of contamination resulting from the identified discharges. Sediment chemistry analysis will be performed on samples from thirty-four sediment grab stations (figure 6). Samples for bioassays will be taken concurrently at twelve of these stations..

The sampling design for the sediment chemistry surface grab stations is based on depth contour strata and systematic spacing. Four strata were chosen:

1) A small intertidal mudflat northeast of the Diagonal outfall,

2) The area between 0 ft. (MLLW) and -10 ft. (0 to 3 m),

3) The area between-10 ft. and -25 ft. (3 m to 8 m),

4) The area deeper than -25 ft. (8 m) and to the east edge of the dredged channel.

The strata run approximately parallel to shore. Samples are collected from within strata 2, 3 and 4 at 100 ft (33m) intervals. Sampling locations also form transects roughly perpendicular to shore but are not placed at regular intervals along the transects.

This systematic-stratified sampling approach provides good coverage of the study area, represents potentially different habitats, allows for statistical groupings and comparisons, and accommodates flexible station positioning in the field if obstacles are encountered.

Simple station names consisting of an alpha site designation and sequential number (e.g, DUD001) are used for ease of communication in figures and tables. Official station locator names are composed of three letters designating the site (i.e., DUD), three numbers designating the station (e.g., 001), two sets of numbers representing the last 4 digits of the two state-plan coordinates (rounded to 10ft), and finally, two digits (i.e., 27 or 83) representing the North American Datum being used. For example station DUD002 becomes DUD002 9430/6950-83 in the data base. Metro and many other agencies are using NAD 27 at present but are planning to convert their measurements and databases to NAD 83 in the near future.

The first stratum is the mudflat, represented by one station. Both sediment chemistry and bioassays will be performed at Station DUD001.

Eleven sediment chemistry grab stations and two bioassay stations are within the second stratum (0 ft. to 10 ft. deep). These stations are spaced 100 ft. apart as described above, from the northern part of the study area to the area around the former sewage treatment plant outfall located upriver. Chemistry at buoy #4 (now station DUD006) and buoy #5 (now DUD005) stations from the 1992 survey will be repeated as part of the sampling within this stratum. The two bioassays stations are the former buoy #5 station and a station where the former sewage treatment plant outfall is suspected to be (DUD011).

Eleven sediment chemistry grabs and five bioassay stations are in the third stratum between 10 ft. and 25 ft. deep. These stations are spaced 100 ft. apart in a broad ribbon

from the north to the area near the former treatment plant outfall. Two 1992 samples were taken near the 10 ft. depth contour; both had compounds exceeding the criteria. No chemistry information exists offshore of the 20 ft. contour. Bioassays are being taken at every other station, beginning with the most northern (downstream) station within this stratum. These stations are DUD016, DUD018, DUD021, DUD023, DUD025.

Eight sediment chemistry grabs and three bioassays stations are in depths greater than 25 ft. extending out to the east edge of the dredged navigation channel. The bioassay stations in this stratum are DUD029, DUD031 and DUD033.

Three more stations are slightly further south (upstream). These stations are near the Diagonal Avenue South storm drain. The stations are placed immediately in front (DUD014,) upstream (DUD015) and downstream (DUD013) of the outfall without regard to strata. Sediment chemistry will be analyzed for at all three and bioassays will be performed on the sample from immediately in front of the outfall (DUD014.).

Surface Sediment Chemistry Tests

The following tests will be conducted on all sediment grab samples;

Conventionals

- Acid Volatile Sulfides (AVS); AVS are closely related to the toxicity of sediment-associated metals. AVS binds potentially available metals, thereby reducing their toxicity (Di Toro et al, 1990).

- Percent Solids (%S); Allows wet-weight values from chemistry analyses to be converted to dry-weight values.

- Total Organic Carbon (TOC); Allows dry-weight values of nonpolar, nonionizable organics to be converted to organic-carbon-normalized values, as required by the SMS (Michelson, 1992). TOC affects the bioavailability of these organic compounds.

- Particle Size Distribution (PSD); Fundamental physical characteristic that influences chemical and biological variables. Finer-grained sediments have higher surface areas and greater sorptive capacity, so differences in

PSD may help explain concentration gradients. The type of benthic community that could be supported is affected by PSD. PSD will drive the need for a silt/clay reference sediment for the bioassays.

Metals

- Arsenic, cadmium, chromium, copper, lead, mercury, silver, zinc; Priority pollutants, required by the SMS.

- Aluminum, antimony, beryllium, iron, nickel, selenium, thallium; Not SMS-required but some have demonstrated toxicity (Konasewich et al, 1982; PTI, 1988). Aluminum and iron also provide an indicator of clay content and uniformity relative to earth crustal elements. There is no additional analytical cost for this data.

Organic compounds

- Extractable base/neutral/acid compounds (BNAs); Priority pollutants required by SMS, Puget Sound Estuary Program (PSEP) chemicals of concern.

- Polychlorinated biphenyls (PCBs); Priority pollutants required by SMS, PSEP chemicals of concern.

- Pesticides; PSEP chemicals of concern

- Tributyltin; Not a SMS requirement. Is a toxic organotin that is a chemical of concern because it has been detected at elevated levels in the area (Weston, 1993).

Surface Sediment Toxicity Tests

Toxicity testing (bioassays) will be contracted to Beak Consultantants Incorporated, a laboratory that has demonstrated experience conducting the tests specified in the SMS and is certified by Ecology for bioassay protocols. Based on the interstitial salinity values (22-33 ppt) measured at the site in the preliminary investigation, the following bioassay tests were selected to be conducted on samples from specified locations;

- *Rhepoxynius abronius* - amphipod 10 day mortality

- *Dendraster excentricus* (sand dollar) - echinoderm embryo mortality/abnormality

- *Neanthes arenaceodentata* - juvenile polychaete 20 day biomass

In the field, two probes and a digital thermometer will be inserted into the first grab sample collected at each bioassay station to measure sediment pH, redox potential (Eh) and temperature. pH and redox potential are important for determining the bioavailability of metals. Temperature is necessary for standardizing the redox potential.

A positive (toxic) control with a reference toxicant (cadmium chloride) is run for each test. Amphipod and juvenile polychaete negative control samples (nontoxic sand) will be taken from the West Beach area of Whidbey Island. The echinoderm bioassay is run with a seawater negative control. To separate grain size impacts from toxicity impacts, reference samples (nontoxic sediments with grain sizes similar to the test sediments) will be collected from near Raft Island in Carr Inlet. Reference samples will not exceed the SMS quality criteria, will come from sites with known performance history, and will be chosen to mimic as closely as possible the grain size and salinity of the test samples. Fine sediments (silts and clay) in the October 1992 samples ranged from 28% to 71%, the remainder being sand. Although the 1992 results are not necessarily representative of what will be found in this investigation, it is anticipated that two reference samples representing two "groups" of grain size ratios will be needed. Bob Suggs of Beak Consultants will train Metro personnel to field screen samples on the first day of test sediment collection. The field screening method requires wet sieving a 50ml aliquot of each sediment through a 0.063 millimiter sieve and measuring the volume of material retained, which is then correlated with known dry weight-based percent fines. Carr Inlet collection sites will be chosen based on the results of the field screening of test sediments. Beak Consultants and Metro will cooperate closely with Ecology personnel in determining the appropriate sites for reference sediment collection prior to the actual collection of these sediments. Carr Inlet reference sediments will also be field screened to verify grain size.

Before the bioassay begins the interstitial salinity will be tested. If the interstitial salinities are not adequate for a specific bioassay organism, adjustments will be made or the test will not be run. The contract laboratory performing the bioassays will routinely monitor the test waters for pH, salinity, temperature and dissolved oxygen. Ammonia

and total sulfides in the overlying water will be measured at the beginning and end of the bioassay to control for test artifacts.

Methyl mercury is formed in sediments by bacterial action and is the form of mercury most readily bioconcentrated in estuarine fish (Konasewich et al, 1982). To determine whether methyl mercury is present in the area, a contract laboratory will test a subsample from each bioassay station composite for methyl mercury.

Sediment Chemistry Cores

The purpose of sediment chemistry cores is to determine the depth of contamination. Sediment cores will be taken at two stations as part of the first phase, with the intent to do more intensive coring in the second phase. A rough estimate of the depth of contamination in the first phase will be useful for designing future sediment chemistry coring efforts. Furthermore, the core sections to be analyzed for lead-210 and cesium-137 in phase II can be determined by identifying where peak concentrations of copper, mercury, silver, PAH's and stable lead are found in the phase I core sections.

The two core stations are noted on Figure 6. One station (DUD020) is offshore of the two outfalls in the third depth stratum. The top 0.9 m (3 ft) of this core will be divided into six, 15-cm (6-in) sections, per figure 7a. All sections will be analyzed to narrowly define the chemical profile, providing valuable input to future sampling needs. The other core station (DUD006) is located in the second stratum between the two outfalls. This station is the site of the 1992 buoy #4 station and is also a Phase I chemistry grab location. Nine sections within the top 1.8 m (6 ft) of the core will be analyzed, as shown in figure 7b. The top 0.9 m (3 ft) of the core will be sectioned like the other core. Between 0.9 m and 1.8 m (3 ft and 6 ft) deep, the bottom 15 cm (6 in) of each 30-cm (1 ft) section will be analyzed.

A thin-walled, 10-cm (4-in) diameter aluminum core tube will be used to collect enough sediment for chemical analysis. The cores will be collected by divers operating either manual slide hammers, pneumatic roto-hammers or pneumatic jackhammers. The sections will be acquired by cutting the core with a pipe cutter around its circumference and extruding the necessary lengths of sediment. To ensure that the desired depth of core sediment is obtained, the core tube will be driven into the bottom 3 feet deeper than the needed sediment depth.

The core sections will be analyzed for acid volatile sulfides, percent solids, total organic carbon, particle size distribution, trace metals, base/neutral/acid extractables, polychlorinated biphenyls, and pesticides.

3.5 PHASE II INVESTIGATION

The need for additional sampling beyond the first phase is likely. It is anticipated that little additional sediment chemistry data will be needed, but more sampling could be needed if bioassay results become a major factor for defining the site. Elements that may be included in the second phase include;

- Habitat survey
- Additional surface sampling for chemistry and/or toxicity for site delineation,
- Additional sediment coring for chemistry depth data to determine volumes of material,
- Sediment samples from Diagonal storm drain line
- Limited coring for lead and cesium isotope dating to determine modelling parameters,
- Additional source control samples,
- Water column or water-sediment interface sampling,
- Elutriate, column leaching and column settling tests to evaluate contaminant mobility, a concern for potential dredging activities,
- Other tests necessary for evaluation of cleanup alternatives.

An addendum to this sampling and analysis plan will be produced to describe the Phase II sampling efforts. Activities repeated in Phase II will reference this report. The addendum will describe, in full, new sampling locations and new sampling methods.

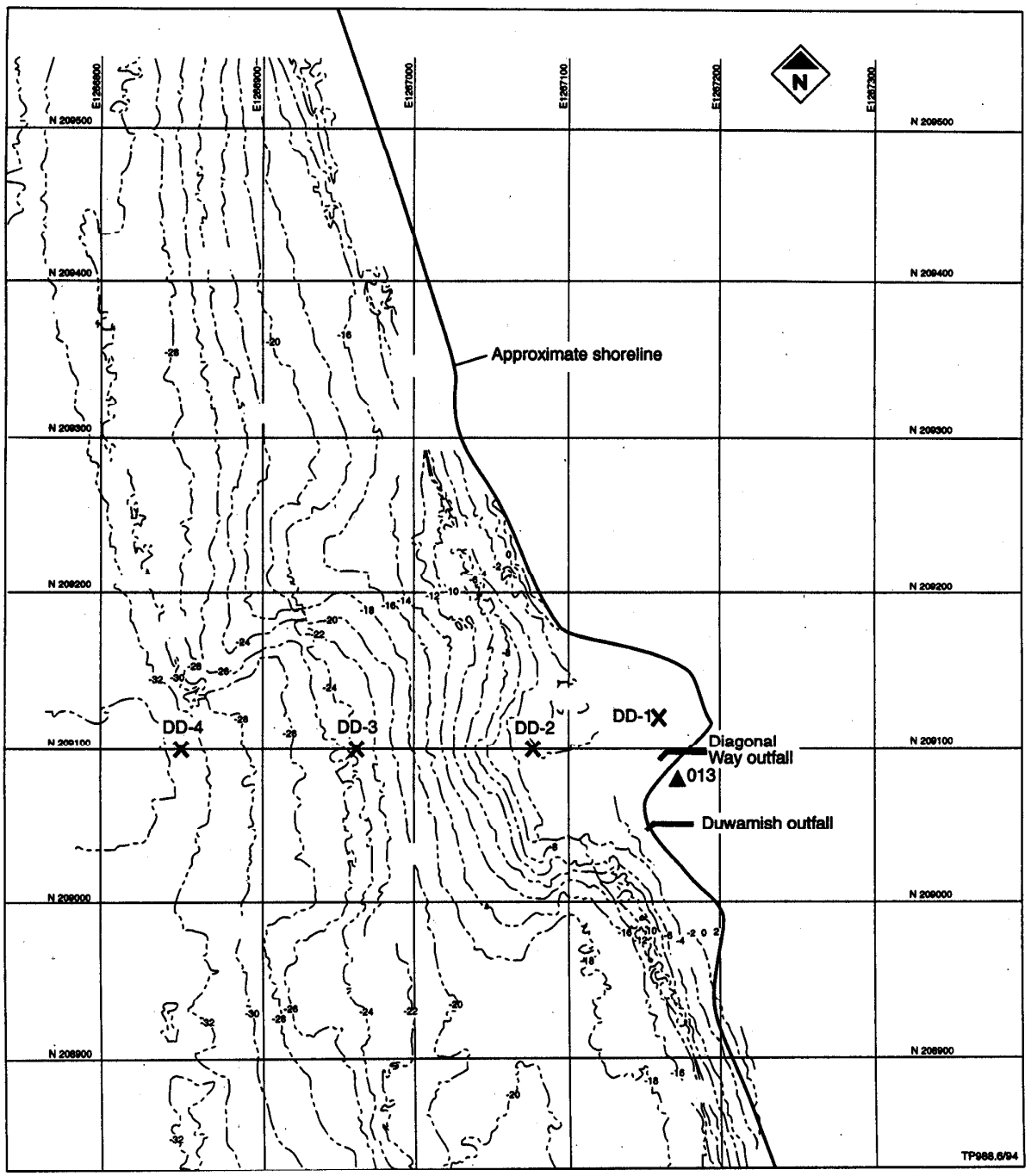


Figure 4. Preliminary Interstitial Salinity Stations

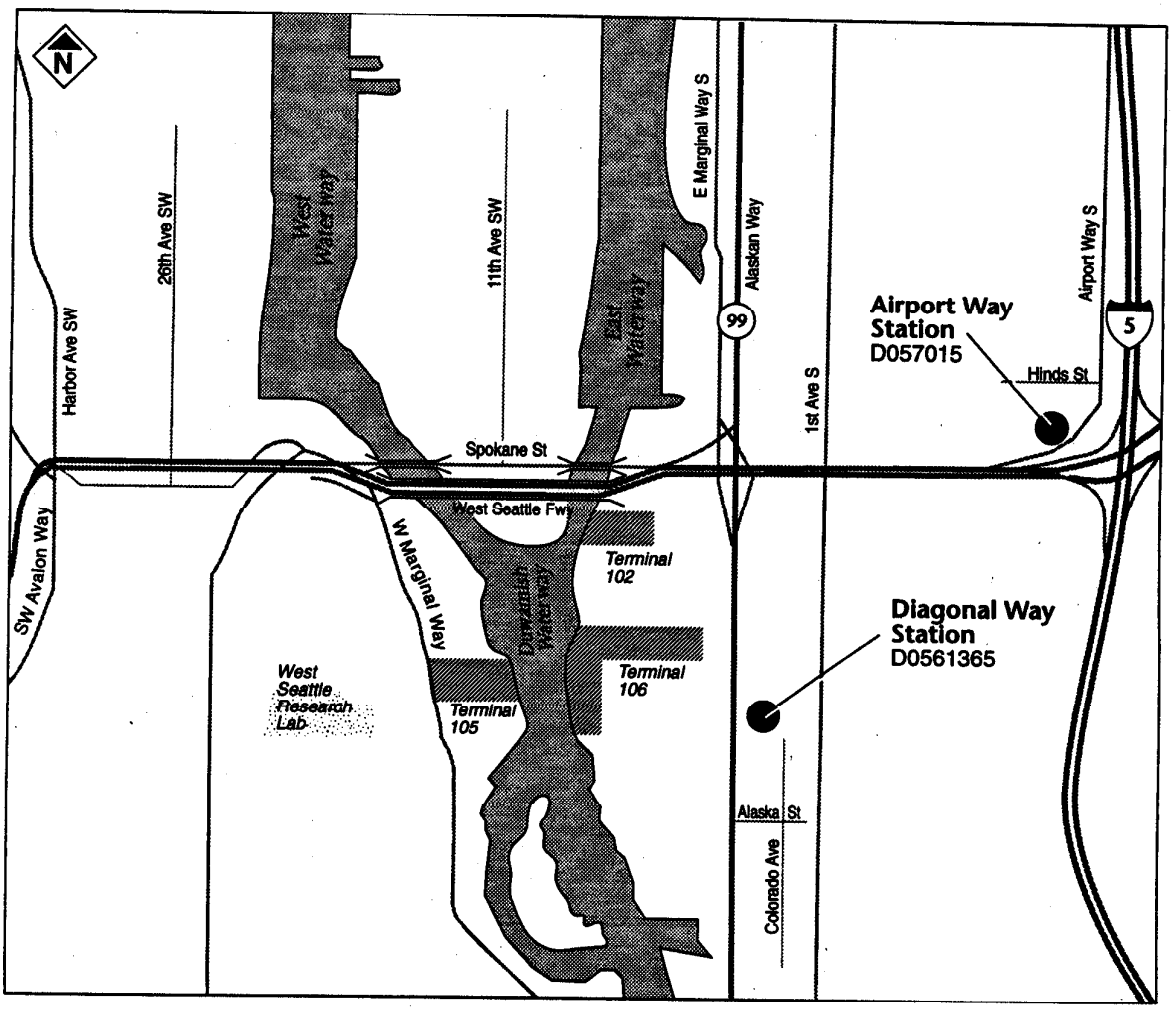


Figure 5. Storm Drain Water Quality Stations

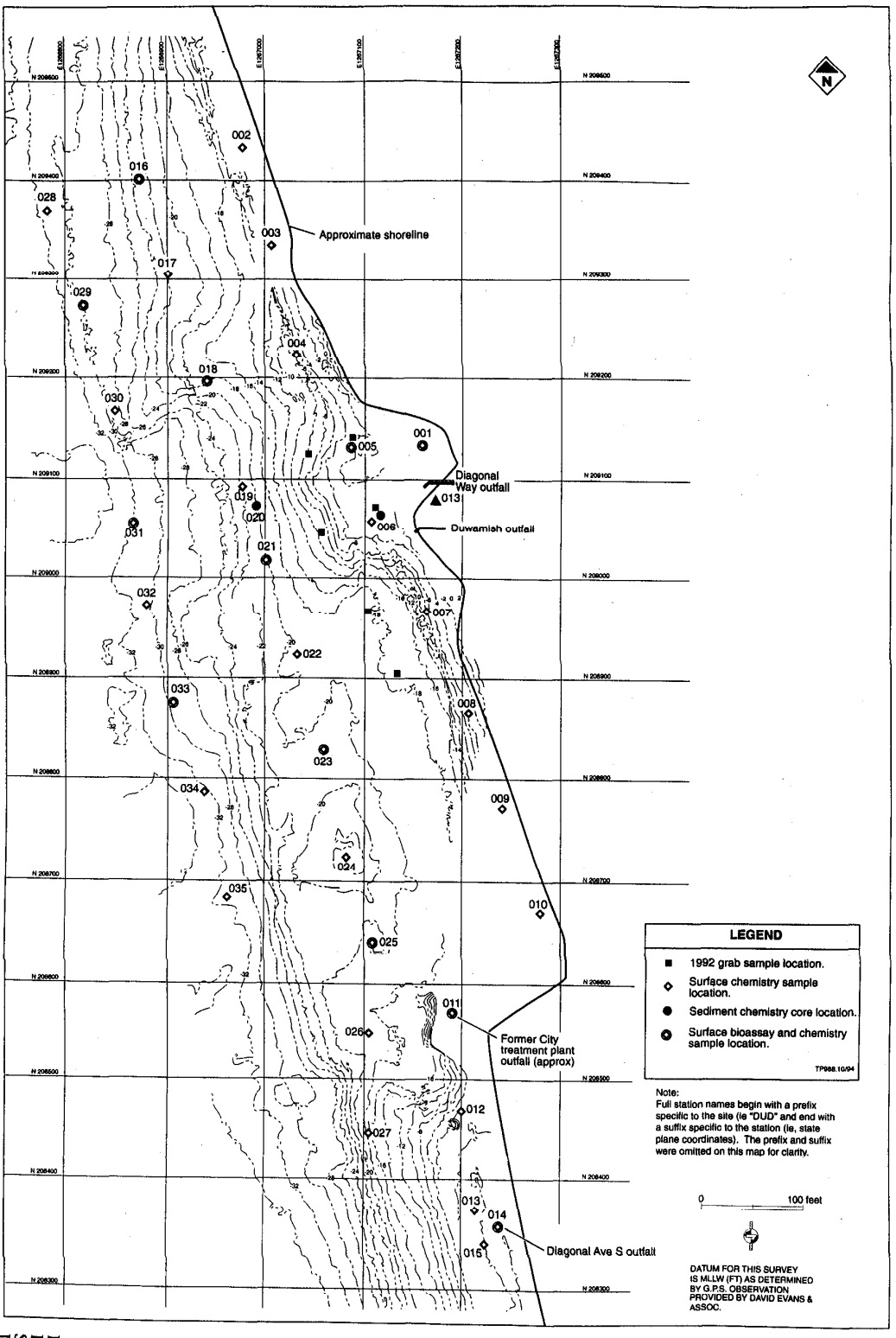


Figure 6.
Duwamish/Diagonal
Sediment Sampling
Locations and
Bathymetry Contours

done in the field electronically by the sampling equipment), or if this is not feasible, samples will be collected as discrete subsamples by the sampling equipment and flow composited by the field crew after the sampling event. Field personnel will adhere to Metro's established confined space policy and safety practices.

In either case, samples are collected with an ISCO Model No. 2700 automated sampler. It is designed to collect up to 24 sequential (discrete) samples or a single composite sample from a liquid source. Samples may be collected at equal time intervals using internal timing circuitry (time-composite) or at equal flow volume intervals using flow pulse intervals from an external flow meter (flow-composite). Time intervals may be set from 1 to 9999 minutes in 1 minute intervals. Flow intervals may be set from 1 to 9999 flow pulses in 1 pulse intervals. Sample volumes of up to 990 milliliters at each sample initiation may be selected in 10 ml increments.

ISCO or SIGMA flow recorders are installed at each site. The recorder provides a strip chart of the water height plotted continuously against time. The recorder is also programmed to trigger sample collections proportionally to the flows.

Exact sampling strategies or procedures to be followed will be somewhat dependent on evaluation of the preliminary flow data collected prior to initiation of storm sampling. This data will provide information about the range of flow levels to be expected and may also provide some information about tidal influence.

In the first round of sampling at least, the sampler will probably be kept outside the maintenance hole to facilitate observation. The intent is to collect flow-paced composite samples if possible, given the potential for tidal encroachment. Sampling is automatically initiated when flows reach a certain level (height) and will stop when the source drops below that level.

Samplers are outfitted with Teflon tubing and either 2.5 or 5.0 gallon glass carboys or 24 300 ml glass sample containers. Clean bottles are placed in the sampler at the site in anticipation of a storm. If a storm that meets project criteria appears to be imminent, the sampler is set to initiate sampling at the appropriate flow level. If a sample is collected but storm or project criteria are not met, the collected water is discarded and the sampler is restocked with clean containers. If the storm meets criteria but sampler

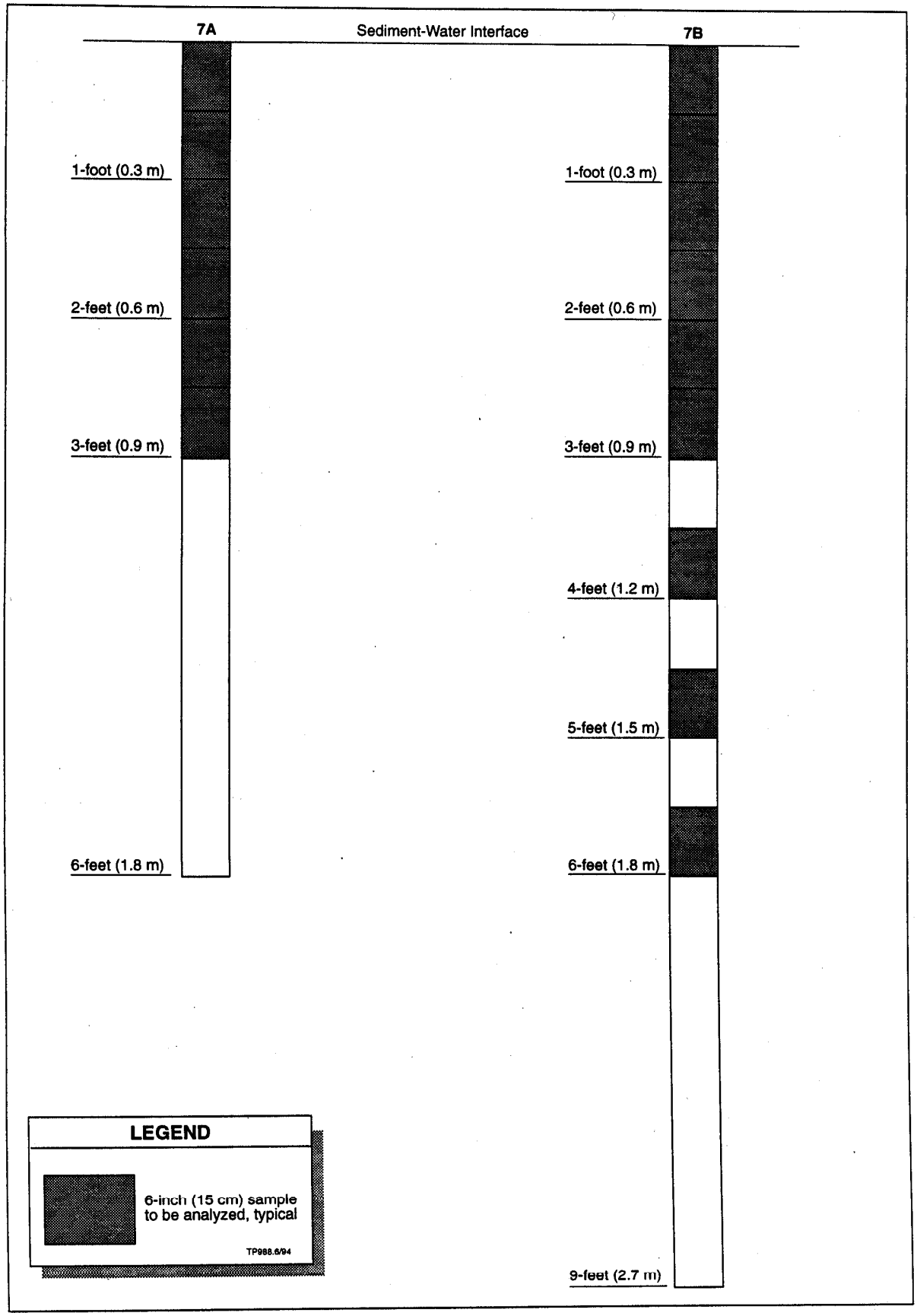


Figure 7. Core Sections

4 FIELD PROCEDURES

4.1 DIAGONAL STORM DRAIN WATER QUALITY

Sampling Locations

Water quality samples and flow data will be collected from manholes tributary to the Diagonal outfall to characterize the discharge. Instead of sampling directly at the outfall, samples will be taken from representative tributary lines because the Diagonal CSO/SD is tidally influenced for a substantial distance (upstream) in the pipe. Samples will be collected at two stations in the basin: from a manhole near the Diagonal outfall (station A) and at a manhole downstream of where flows from the Hanford tunnel discharges to the Diagonal drainage system (station B) (figure 5). Station A (manhole D056136) is located on Diagonal Avenue South approximately 175 ft (50 m) upstream of the junction structure where Diagonal intersects with Colorado Avenue South and Denver Avenue South. This is approximately 2,200 ft (680 m) east of the Diagonal outfall. Station B (manhole D057015) is located in a parking lot near the intersection of Airport Way and 8th Avenue South. Station B is located approximately 5,100 ft (1.5 km) northeast of Station A.

Sample Collection Procedure and Equipment

Five samples will be collected from each site: one sample during a period of relatively dry conditions to represent "baseline" conditions, and four samples during storm events. Two of the four storm samples will be collected during the "wet" season (November through April) and two of the samples will be collected during "dry" season storms (May through October). All of the storm samples are analyzed as flow-proportioned composite samples except for volatile organic samples which are collected as single grabs. The "baseline" sample is a one-time grab sample. Depending on how the sampling equipment can be installed at the selected sites, and on the tidal regimes at the selected sites, samples will either be collected into one sample container (compositing

Organics

One-liter bottles are emptied and rinsed with tap water. Washed in lab dishwasher which includes detergent wash, rinses and RO water rinse. Placed in kiln and baked at approximately 400 degrees celsius for 6 hours. Caps are double washed in the dishwasher.

The caps and septa of the 40-ml vials are double washed in the lab dishwasher, reassembled, and placed on new vials as they come from the factory.

Conventionals

Widemouth plastic bottles are soaked in water with a small amount of phosphorous-free detergent. They are then cycled through the laboratory dishwasher and rinsed 5-6 times with deionized water.

Sample Acceptability Criteria

Baseline Sampling

A grab sample will be collected when it is not currently raining and no rain has fallen during the previous 48 hours.

Storm Sampling

In order for the modeling effort to be successful, both sampling sites need to be sampled simultaneously, during periods of adequate rainfall, and without tidal encroachment in the storm drains being sampled. A storm sample will be considered valid if 2 to 4 hours of non-tidally influenced sample have been collected during a storm event with a minimum of ¼-inch of rainfall. No change in flow is observed for storms of less than ¼-inch. No specific upper limit is set. After a storm event is sampled, the timing of the sampling relative to the timing and magnitude of rainfall during the event will be reviewed. The sample will be rejected if it is determined to be unrepresentative of the event. If it appears, based on previous flow records and/or by visual inspection of the site that there may be tidal encroachment during the sampling period, the sampler will be set up for discrete samples, in conjunction with the flow meter, flow-paced if feasible and time-paced otherwise. The individual samples will be tested with a conductivity meter

capacity is insufficient for the duration, extra bottles are available to complete the sampling.

Samples are transported to the laboratory in the sample-collection jugs/bottles. If auto-composited, samples are homogenized on a magnetic stirring plate and split into appropriate laboratory sample containers. The organics lab receives 1.0 liter glass bottles and, for volatiles, 40 ml glass vials prepared with sodium thiosulfate and so labeled. The sample container for metals analyses is a 500 ml acid-washed plastic bottle, and the sample is preserved with ultra pure nitric acid immediately after splitting. The conventionals laboratory receives a 1 liter nalgene bottle of sample. If samples are discrete, they will be manually flow-composited into a single container, then homogenized and split as above. Discrete samples are tested with a conductivity meter; if salinity is detected the sample is discarded and the remaining samples are composited. The conductivity measurements of all samples are recorded. If a sample is discarded the flow volume that sample represents is noted.

Sample Container Cleaning

Field

Tubing, containers and carboys used in the field are cleaned by a 24-hour microsoap soak, followed by a 24-hour soak in 5% sulfuric acid, then rinsed eight times with RO (Reverse Osmosis) water.

The ISCO sampler pump tube is removed from the sampler and sent through a sonicator for 24 hours, three RO water washes, washed with 5% sulfuric acid, followed by 3 more RO water washes.

Metals

Bottles are soaked overnight in microsoap. Items are rinsed thoroughly with tap water followed by 3 rinses with RO water. Items are then soaked overnight in 20% nitric acid solution. After the acid soak, items are rinsed 8 times with RO water and placed on paper towel covered racks to dry, upside down.

- Transfer custody of the samples to the appropriate COC lockers and refrigerators. Document the transfer on the appropriate COC record-keeping form and/or logbook.

- Notify the appropriate people that the samples have arrived.

4.2 BATHYMETRY

A bathymetric survey extending beyond the study area was conducted in April 1994 by David Evans and Associates and Golder Associates Inc. The survey area encompassed an area extending roughly 150-m (500-ft) downstream and 450-m (1500-ft) upstream of the Duwamish outfall, from the shore to the center of the channel.

Bathymetry data was collected with a Reson Seabat 9001 Swath Bathymetry Sonar System. The system records 60 soundings at once in a 90 degree swath. Three swaths are completed each second, giving a total of 180 soundings per second. Fixes are taken at 3 meter intervals with 10 values acquired within the interval. The survey vessel ran transects parallel to shore.

Navigation and positioning of the survey vessel was accomplished with a Trimble Model 4000SSE differential global positioning system (DGPS) integrated with Interspace 488 Coastal Navigation software. The navigation antenna was mounted amidships on the port side of the survey vessel. An onshore GPS receiver was placed on a known control point, DIA013 (Diagonal CSO). The onshore receiver provided real-time corrections to the ship-board DGPS receiver at a rate of 1/second.

A staff gauge was set up and leveled to MLLW by the Diagonal outfall structure to provide a means of correcting for tidal stage.

The navigation system provided a real-time display of the survey vessel, pre-plotted survey grid, and boundaries of the survey area on a color monitor located in the pilot house. During the survey the navigation system acquired and logged the vessel position, recorded the bathymetric data, and provided fix marks to the geophysical data display recorders.

and those indicating saline influence will be discarded. The remaining samples will be flow composited.

Sample Rejection

Any sample will be rejected if the integrity of the sample container has been compromised (e.g., broken, cap loose). A sample will also be rejected if it has not been properly prepared, or if it has been kept at improper temperatures or beyond the allowable holding time. Depending upon the number and priority of unacceptable samples involved for any given sampling effort, either the entire sampling series will be redone or the sample loss will be so noted in the sample report.

Field Documentation

Metro's chain of custody (COC) procedures were established to monitor for compliance, or to sample a discharge that is suspected of violating discharge regulations. COC procedures are followed from the time of sample collection to the conclusion of laboratory analysis. Laboratory COC is documented later in this report.

Field chain of custody (COC) procedures include:

- Collect the sample according to approved procedures
- Label the sample container, before the sample collection run,
- Enter collection information on appropriate COC record-keeping forms. Information of importance includes crew members' names, date, time, sample number, location, observations, and special notes that will aid sample analysis,
- Insure that the sample is in your possession, view or secure storage at all times.
- Transport sample to the laboratory as soon as possible, observing proper EPA preservation and holding-time requirements.

- Overlaying water was present (indicates minimal leakage), but not excessively turbid (indicates minimal disturbance),
- A relatively flat sediment surface.

Prior to taking a subsample from the grab the overlying water was drained away gently by cracking the grab sampler. A 2 inch diameter stainless steel tube was inserted into the grab to a depth of about 10-cm, two or three times, to collect enough sediment to fill a 250-ml plastic container.

The intertidal sample was collected by scooping sediment with the spatula into the 250-ml container.

Dominant sediment type and penetration depth were noted. The bottles were stored in an ice chest without ice. When samples were returned to the laboratory they were logged in and stored in a refrigerator until processed.

4.4 SURFACE CHARACTERIZATION

The selection of surface sediment chemistry and toxicity station locations is described in section 3. In short, grabs for sediment chemistry will be collected at 34 stations in a systematic-stratified scheme. Surface sediment chemistry and bioassay samples are collected with a 0.1-m^2 van Veen grab. A 10-cm deep subsample from the center of the grab sample is taken for analysis. Two or more grabs are composited at each station where only sediment chemistry analyses will be performed to obtain the needed volume. Samples for bioassay analysis will be collected at twelve of these stations. Three or more grabs are composited when both sediment chemistry and bioassays analyses are needed to provide ample sediment volumes without taking sediment near the edges of the sampler. Performing the analyses on composite samples, instead of individual discrete samples, is a generally accepted way of reducing field variability.

In addition, two types of replicate samples for chemistry analyses will be collected; random field replicates and a series of replicates at a station with levels of contamination near the SQS.

An ASCII-based electronic file of contour lines will be provided in addition to a paper contour plot.

4.3 PRELIMINARY INTERSTITIAL SALINITY

Seven samples at four stations (figure 4) were taken in March 1994 to estimate the range of interstitial salinities that may be encountered at the site. A van Veen (0.05-m^2) grab sample was taken at each of three subtidal stations. Two samples were taken from each van Veen to provide a sample and a replicate. A sample from a fourth station in the intertidal cove was collected with a stainless steel spatula. A replicate was not taken at the intertidal station.

Each strata was represented by one station. The three subtidal stations were on a transect extending roughly westward of the Diagonal outfall, which was exposed at the low tide when the samples were collected. The transect was navigated to by using an improvised range mark consisting of lining up the most southerly of two electric wire towers on the east shore with the next single electric pole to the east. Stations along the transect were determined by navigating to a depth representative of the strata, as determined by a depth sounder and estimated corrections for tidal stage. Buoys were deployed at the three subtidal stations before sampling began, at depths of 31 ft, 24 ft and 3 ft. The intertidal station was chosen by walking to a central point in the exposed mudflat at an estimated elevation of +1 ft..

At the two deepest subtidal stations, the van Veen grabs were deployed from a 28-ft vessel equipped with an "A" frame and power winch. The van Veen grab was attached to a hydrowire with a swivel and shackle. At the shallow subtidal station (3-ft depth) the van Veen was deployed manually from a 12-ft aluminum boat. After the grab was secured onboard, the sample was inspected for the following criteria;

- A penetration depth of at least 8 cm, and more desirably 10 cm, to represent future samples of 10 cm,
- The sampler was not overfilled,

converted to hours, minutes and seconds for use in the field. All backsites and reference points are verified in the field prior to sampling.

On the day of sampling, a Sokkisha electronic total station (combined theodolite and infra-red electronic distance-measuring instrument (EDMI)) is manned at the shore reference station (DIA013). Temporary shore reference stations may be established if obstacles such as barges are encountered. The EDMI targets in on an Omni 360 degree prism cluster mounted on the survey vessel. The survey vessel is directed by the shore-based surveyors to within ±3 m of a sampling station and a buoy is deployed from near where the target prism is mounted.

Once all the buoys are deployed, the survey vessel proceeds to collect samples at each station. The prism cluster is moved towards the stern of the boat where the grab sampler is to be deployed. The survey vessel returns to a buoy and confirms that the corrected water depth is within the intended stratum. The shore-based surveyor confirms that the boat is within ±3 m of the station the first time the grab sampler is deployed at a station. The surveyor notes and reports the position of the vessel the first time the sampler impacts the bottom. This position will serve as the "fix" for the composite sample. The boat crew notes the position relative to the buoy when the first grab is taken. Subsequent grab samples will be taken relative to the buoy.

Depths are referenced to MLLW with corrections from a staff gauge installed at the Diagonal Way CSO. The staff gauge will be installed under known tidal and river flow conditions, and verified by comparison to the height of the reference station and the NOAA subordinate station on Harbor Island at the former Lockheed Shipyard. Measured ranges and angles are converted to and stored on a database as horizontal state-plane coordinates referenced to the Washington coordinate system, north zone, 1983 North American Datum (NAD83). State-plane station coordinates will be converted to latitude and longitude for the Cleanup Study Report and in electronic files submitted to Ecology.

Sampler Deployment

Subtidal surface sediment chemistry and bioassay samples are collected with a chain-rigged 0.1-m^2 van Veen grab attached to a hydrowire via a shackle and ball-bearing swivel. A safety-pin is inserted before the sampler is lifted off the vessels deck or sample platform and pulled once the sampler is overboard, immediately before lowering.

Metro routinely takes random field replicates in the same manner as regular samples at ten percent of the stations; in this case, three randomly selected stations (to be determined immediately prior to sampling). Field replicates are useful for determining total sample variability (analytical variability plus field variability).

Errors from analytical procedures are small compared to field variations, particularly for metals (Krumgalz et al, 1989). Site clean up boundaries are delineated by comparing concentrations to the SQS: stations with concentrations lower than the SQS may not be cleaned up. Depending on the rate of natural recovery and whether specific contaminants have a widespread distribution that is not related to the pipes under investigation, the MCUL may also be used to delineate site boundaries. With only one composite sample at a station, field variability may lead to wrongly classifying a station as having contaminant levels above or below the SQS or MCUL. If field variability can be estimated and the range of values is small, then one composite sample per station can be considered sufficient to delineate the site. If the range is large, additional composite samples may need to be taken in Phase II at stations on the outer boundary of the proposed cleanup area to be sure that the appropriate area is being remediated. To estimate field variability in samples with several parameters at concentrations near the SQS and MCUL, a series of five composite samples at station DUD021 will be analyzed for sediment chemistry. This station was chosen because it is centrally located, is proximate to stations known to have concentrations above the SQS and MCUL, and is likely to be affected by the two sources under investigation. The samples will be taken, composited and analyzed by the same means as other sediment chemistry samples. The inherent scatter, or field error, will be estimated by the mean and standard deviation of concentrations of certain parameters. This scatter, in turn, will represent the field variability inherent at concentrations near the SQS and MCUL, and therefore may help delineate the site based on significant impacts.

Positioning

Coordinates, azimuths and distances are all determined in advance. Sample locations are chosen based on the systematic-stratified approach described in section 3. The approximate state plane coordinates of each station are derived from figure 5 which was produced by a computer-aided design program that has the ability to pinpoint locations according to state-plane coordinates. The shore reference station and backsite reference points are surveyed positions with known coordinates. The angle (azimuth) and distance from the shore reference station to the sampling stations and backsite are calculated and

Samples meeting these criteria will be processed according to the procedure in the following sections.

Sample Documentation

The same field Chain of Custody (COC) procedures described under the storm water collection apply to the collection of sediment samples. Please refer to the Field Documentation portion of section 4.1.

Metro's COC procedures begin with the creation of Fieldsheets with preassigned "products" (e.g., sample numbers, locators, location descriptions, and parameters to be analyzed). Fieldsheet products are described and an example is included on the following pages. Each composite sample from a station is assigned a unique number that will be used to identify the sample for all field, laboratory and reporting purposes. In other words, subsamples (i.e., for specific parameters) from a composite sample have the same sample number.

Based on the fieldsheets, sample containers are labeled with preprinted sample labels with station and sample information plus the parameter(s) that container contents are intended for.

A Laboratory Work Order form is the COC form that accompanies samples throughout analysis. This form tracks transfers of sample custody between field personell, to and within Metro's Environmental Laboratory, and to contract laboratories.

The subsample for acid volatile sulfides comes from the first acceptable grab of a series of grabs taken at a station. pH, Eh and temperature measurements are also conducted on the first of the accepted grabs. Additional grabs are collected from that station and each is evaluated individually according to the above criteria. Fieldsheets are completed when enough acceptable samples have been obtained. When the field sheet is completed the samples are combined, homogenized and split. The penetration depth of each of the grabs is noted on the fieldsheet and the average depth is calculated for the database.

The sampler is lowered by a HIAB hydraulic crane and winch. At 5 m above the bottom the lowering speed is reduced to a speed of approximately 1 ft/sec. A position fix is taken the first time the sampler hits bottom. After impact, the sampler is raised slowly off the bottom to allow the sampler to close properly. When the sampler is free of the bottom, as evidenced by reduced strain on the winch motor, the speed can be increased to a constant speed of approximately 1 ft/sec. While being brought aboard and once secure, the grab is visually evaluated for the absence of water leaking from the sides or bottom due to rocks, sticks or organisms caught in the jaws of the grab. If necessary, the boat is maneuvered to minimize vessel rolling to help minimize sample disturbance.

Intertidal stations may be sampled at low tide by walking to the site and removing sediment to a depth of 10 cm with stainless steel spatulas.

Sample Acceptability Criteria

After recovery, the grab is placed in a large plastic tub while remaining closed. The hinged lids on top of the sampler are opened and the sample is inspected for the following criteria.

- Hinged lids remained sealed to prevent sediment loss at surface
- Sediment surface is not pressed against the top of the sampler
- Sediment surface is relatively flat (not canted with partial sample or washed near sides of the grab)
- Overlying water is present to indicate minimal leakage
- Overlying water is not excessively turbid
- The penetration depth is at least 10.5-cm for a 10-cm-deep sample.

If a sample does not meet any one of these criteria, it will be rejected. If the sampler can not obtain an acceptable sample after a reasonable number of attempts a larger van Veen grab or another type of grab sampler will be employed. The station position may also be shifted slightly.

- Collect date: Year, Month and Day sample was collected, expressed as YYMMDD.

- Time: Time of day at which sample is collected, expressed in local military time.

- Sample Depth: Water depth as recorded by an echo-sounder.

- Tide Height: Estimate of the present height of the tide relative to MLLW. Estimate obtained by reading a staff gauge established within viewing range of the vessel or shore-based surveyor.

- Sediment Depth: The depth to which the sampler penetrated the sediment.

- Sample Recovery: Estimate of the depth of sample recovered from a sampler. This will likely differ from the Sediment Depth because the sediment in contact with the bottom of the grab is to be excluded and only the top 10 cm of sediment are desired for analysis regardless of the penetration depth.

- Comments: Details that may not be available in other products

- Personnel: Initials of people onboard

- Sample Function: Space for recording pH, Eh, and temperature field measurements for bioassay samples.

- Sample Method: Five digit numeric code used by Metro's Environmental Laboratory to identify the gear used for sampling. Code is composed of codes for Sampling Category (e.g., core, grab, autosampler), Sampler Type (e.g., van Veen), and Sampler Usage (i.e. accepted methodology). A description of the coding heirarchy and list of methods is provided in Appendix A.

- Sediment Type: Five character alpha-numeric code used to estimate principal and secondary particle size fractions, debris in the sample, sample color and odors. A list of code characters is provided in Appendix A.

- Department, Matrix, Product; This identifies which parameters will be analyzed for from that sample. Department is a one digit number representing the laboratory responsible for analysis (e.g., Conventionals, Metals, Organics).

The project manager maintains notes about the station position, characteristics of the sediment and sample quality of each individual grab sample. This information is stored in a logbook and/or a standard format like the included Sampling Notes form.

Samples will be kept onboard in ice chests and secured with custody tape. The samples and accompanying forms will be transported to Metro's laboratory by the end of the day and stored according to proper holding procedures described under laboratory protocols (see next section).

Fieldsheets

The following products will be included on all fieldsheets used at sediment stations.

- Sample Number: Unique alpha-numeric number assigned by the Metro laboratory that identifies all subsamples from a composite. This number is used throughout the analysis and reporting stages.

- Locator: Project- and site-specific alpha-numeric code used to identify stations. The first three digits (DUD) identify the site, followed by three digits used to identify specific stations within the site. The next eight digits of the code (e.g., 8920/7130) represent the last four digits of the northings and eastings, respectively, of the target station rounded to the nearest 10 ft (3 m). The actual true coordinates measured in the field by the survey crew will be recorded without rounding, transferred to the field sheet, and entered into the computer data base. The last two digits indicate the North American Datum the state plane coordinates are based on (i.e, 1927 or 1983).

- Short Locator Description: Project-specific description of the site and station number. May also be used to indicate whether sample will be analyzed for sediment chemistry only or sediment chemistry and bioassays.

- Locator Description: Expanded version of the Short Locator Description with the site name, type of sampler and station.

- Site: General description of the body of water where samples are from, in this case it will be "Duwamish River".

Matrix is the type of material (i.e., marine sediment is SALTWTRSED, storm drain water is STORM WTR). Products are the parameters to be analyzed for, and helps identify the types of sample containers needed.

Laboratory Work Order

The Laboratory Work Order (LWO) form has the necessary identifiers for tracking samples. Three copies of each LWO are produced: two are used for the laboratory COC and one is given to the project manager for recordkeeping. A LWO is filled out in the field as samples are collected and is kept with samples through transfers, storage and analysis. Additional LWO's may be generated as the samples are sent to contract laboratories and sections within Metro's Environmental Laboratory, but the following identifying information will not change.

- Client Sample ID: A number assigned by the Metro lab to the project
- Date Sampled: Same as Collect Date on fieldsheet
- Time: Same as Time on the fieldsheet
- Matrix: Same as Matrix on the fieldsheet
- Metro LIMS No.: Same as Sample Number on the fieldsheet

Sampling Notes

The sampling notes are intended as reference notes for the project manager and other personnel. They are not part of the COC procedures, and do not accompany the samples to the laboratory. Instead, the project manager will keep the notes for future reference. Measurements and notes made in the sampling notes will be used to maneuver the survey vessel onto station for the second and third deployment of a grab at a station, record qualitative observations in the field, and verify information on the database. An example of a sampling notes form is included in this report. Copies of the sampling notes and other field logs will be included in the appendix of the Cleanup Study Report.

METRO ENVIRONMENTAL LABORATORY 322 W. Ewing Street Seattle, WA 98119-1507 (206) 684-2300 Fax: (206) 684-2395 page __ of __ pages

LABORATORY WORK ORDER

Organization:

Address:

Phone: Fax:

Project Name:

Project Number:

Client Sample ID	Date Sampled	Time	Matrix	Metro LIMS No.	Requested Parameters	NO. OF CONTAINERS	COC Handling Required?: Yes / No Samplers: Shipment method: Observations, Comments, Special Instructions

RELINQUISHED BY	Date	RECEIVED BY	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Organization		Organization	
RELINQUISHED BY	Date	**RECEIVED BY**	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Organization		Organization	

Total Number of Containers: Requested TAT:

Additional Comments:

Figure 9. Laboratory Work Order

Fieldsheet ID: A44703_14MAY93_144044 Page: 5

Pier 53 Sediment Cap

Project Number: A44703 Personnel: _____

Sample Number	P1145-7	P1145-8	P1145-9
Locator	P53VG6	P53VG7	P53VG10
Short Loc. Desc.	Pier53VG6	Pier53VG7	P53Grab10
Locator Desc.	Pier 53 Van_Veen 6	Pier 53 Van Veen 7	Pier 53 Van Veen 10
Site	SEATTLE WATERFRONT	SEATTLE WATERFRONT	SEATTLE WATERFRONT
Sample Depth			
Collect Date	930521	930521	930521
Comments	MAY '93 SED. CAP VV GRABS	MAY '93 SED. CAP VV GRABS	MAY '93 SED. CAP VV GRABS TOP 10 CM
DATE, INDIV			
PERSONNEL			
SAMP FUNC			
SAMP METH	20037		
SED DEPTH	6.9	9.1	14
SED TYPE	32N21	32N21	20N15
TIME	1253	1223	1026
Dept., Matrix, Prod			
	1 SALTWTRSED AL	1 SALTWTRSED AL 9	1 SALTWTRSED AL 17 4 17 11
	1 SALTWTRSED BNA	1 SALTWTRSED BNA 9	1 SALTWTRSED BNA
	1 SALTWTRSED CLPESTPCB	1 SALTWTRSED CLPESTPCB 7	1 SALTWTRSED CLPESTPCB
	1 SALTWTRSED FE	1 SALTWTRSED FE 10	1 SALTWTRSED FE 2 grabs only
	1 SALTWTRSED HG 7	1 SALTWTRSED HG	1 SALTWTRSED HG
	1 SALTWTRSED PP-MET	1 SALTWTRSED PP-MET 26	1 SALTWTRSED PP-MET
	1 SALTWTRSED PSD	1 SALTWTRSED PSD	1 SALTWTRSED PSD
	1 SALTWTRSED TOC	1 SALTWTRSED TOC	1 SALTWTRSED TOC mud
	1 SALTWTRSED TOTS 7	1 SALTWTRSED TOTS	1 SALTWTRSED TOTS
	1 SALTWTRSED VOA-GC/MS	1 SALTWTRSED VOA-GC/MS	1 SALTWTRSED VOA-GC/MS black
	3 SALTWTRSED PSD	3 SALTWTRSED PSD	3 SALTWTRSED PSD heavy
	3 SALTWTRSED TOC 3	3 SALTWTRSED TOC	3 SALTWTRSED TOC
	3 SALTWTRSED TOTS	3 SALTWTRSED TOTS	3 SALTWTRSED TOTS det. smell
	6 SALTWTRSED AL	6 SALTWTRSED AL	6 SALTWTRSED AL

continue ...

Figure 8. Fieldsheet Example

Sampling Notes			SAMPNOTE.XLS
Personnel:		Time:	
Station:		Type: Grab or Core	G C
Sample Number:		Core Length	FT M
Date:		Chemistry/Bioassay	Chem Both
	4th Deployment	**5th Deployment**	**6th Deployment**
Distance from buoy	FT		
Compass bear. to buoy	degrees		
Line of sight			
Observations			
Leakage;	Y N	Y N	Y N
Winnowing:	Y N	Y N	Y N
Disturbance:	Y N	Y N	Y N
Water on Top:	Y N	Y N	Y N
Measurements			
Penetration/Core dept	CM	CM	CM
Core section			
pH			
Eh			
Temperature	deg C	deg C	deg C
Volume retained			
Characteristics			
Texture	Smth Fine Crse	Smth Fine Crse	Smth Fine Crse
Color	Gray Brwn Blk	Gray Brwn Blk	Gray Brwn Blk
Biological Structures			
Debris Present			
Debris Removed			
Oil/Debris Sheen	Oil Debris None	Oil Debris None	Oil Debris None
Odor			
Comments			

Sampling Notes			SAMPNOTE.XLS
Personnel:		Time:	
Station:		Type: Grab or Core	G C
Sample Number:		Core Length	FT M
Date:		Chemistry/Bioassay	Chem Both
Target Station		***Actual Station***	
Reference Range	FT M	Reference Range	FT M
Reference Angle	degrees	Reference Angle	degrees
Northing	FT	Northing	FT
Easting	FT	Easting	FT
Water Depth	FT	Water Depth	FT
		Tide Height	FT
		Corrected depth	FT
	1st Deployment	**2nd Deployment**	**3 rd Deployment**
Distance from buoy	FT		
Compass bear. to buoy	degrees		
Line of sight			
Observations			
Leakage;	Y N	Y N	Y N
Winnowing:	Y N	Y N	Y N
Disturbance:	Y N	Y N	Y N
Water on Top:	Y N	Y N	Y N
Measurements			
Penetration/Core dept	CM	CM	CM
Core section			
pH			
Eh			
Temperature	deg C	deg C	deg C
Volume retained			
Characteristics			
Texture	Smth Fine Crse	Smth Fine Crse	Smth Fine Crse
Color	Gray Brwn Blk	Gray Brwn Blk	Gray Brwn Blk
Biological Structures			
Debris Present			
Debris Removed			
Oil/Debris Sheen	Oil Debris None	Oil Debris None	Oil Debris None
Odor			
Comments			

TABLE 1: SEDIMENT CONTAINERS AND STORAGE CONDITIONS FOR SURFACE SEDIMENTS

Parameter	Storage conditions	Container Volume	Container type
AVS	Dark, 4°c	(2) 60 ml vials	Glass vials
% Solids & TOC	Freeze, -18°c	100 ml	Plastic
PSD	4°c	1 liter	Glass
Metals	Freeze, -18°c	100 ml	Polyethylene
Mercury	Freeze, -18°c	From metals container	Polyethylene
Organics	Freeze, -18°c	500 ml	Glass/teflon lid
Tributyltin	Freeze, -18°c	500 ml	Glass/teflon lid
Interstitial salinity	4°c	500 ml	Plastic
Methyl mercury	Freeze, -18°c	125 ml	Glass
Amphipod	Dark, 4°c	3 liters	Plastic Bag
Echinoderm	Dark, 4°c	1 liter	Plastic Bag
Polychaete	Dark, 4°c	3 liters	Plastic Bag

Sampler Decontamination and Container Cleaning Procedures

Sample contamination must be avoided during sample collection. All sampling equipment, sample containers, utensils, instruments, working surfaces and other items that may come in contact with the sediment should be made of a noncontaminating material (e.g., glass, stainless steel, PTFE plastic) and cleansed properly prior to use.

The van Veen grab samplers will be cleaned between sample sites using the following procedure:

1. Soap (detergent 8) and water scrub
2. Triple rinse with site water (rinsate collected)
3. Thorough in-stream site water rinse

These procedures are an exception to the Puget Sound Protocols, and are implemented to avoid the use of both acetone and methylene chloride in the field. The soap and water scrub will be equally effective for toxicity testing purposes in removing any film of contaminants that might present a carryover problem, and will avoid three additional problems:

Sample Containers

Composite samples from sediment chemistry only stations are split into seven containers, for a total volume of approximately 2.3 liters. When bioassays are run, five additional sample containers are needed (even more if amphipod and polychaete samples are stored in more than one container). The total volume necessary for the chemistry, bioassays and accompanying tests is approximately 10 liters. A $0.1m^2$ sediment grab can capture more than 10 liters of sediment. However, we will take multiple grabs and composite them to reduce field variability and lessen the potential for contamination from contact with the van Veen grab edges.

Samples that will be frozen require a headspace of up to ¼ the volume. The volume listed below is the volume of the sample container. Allowances have been made for headspace. In all cases, the amount of sediment requested is more than required for analysis and quality control purposes. The extra sediment will be archived in case the analysis needs to be repeated.

Table 1 lists the parameters, preferred storage conditions, container volume and type. Freezing of samples will not be possible in the field, so all jarred samples will be stored in ice chests with ice until delivered to the laboratory at the end of the day. Potential sediment bioassay contractors recommended that bioassay subsamples be put into plastic bags and then into 5 gallon buckets for transport.

2. If the sample is acceptable, slowly siphon off the overlying water from near one side of the sampler.

3. Unwrap previously cleaned stainless steel spatulas and spoons.

4. Using two clean stainless steel spatulas or a spoon, remove a slice of sediment through the flaps from near the center of the sampler. Transfer slice to 2 60-ml glass vials for AVS analysis. Fill the container completely full so there is no headspace. Place the cap on the container. Store in ice chest.

5. If bioassay subsamples are to be taken, insert probes for pH and Eh and a thermometer through the flap opposite where the AVS sample was taken. Insert the probes to a depth of 2 cm and allow meter to stabilize, approximately 15 minutes. Measurements are recorded on the fieldsheet and Sample Notes forms.

6. Note the physical characteristics (texture, color, oil sheen, etc) on the sampling notes and in code under Sediment Type on the fieldsheet.

7. Using the same utensils as for the AVS subsample, remove the top 10 cm of sample from the center of the sample, being careful to exclude sediment in contact with the edges or bottom. If the composite sample is intended for analysis of sediment chemistry only, then remove an area measuring approximately 10 cm by 15 cm to a depth of 10 cm. If both chemistry and bioassay tests will be run, remove an area measuring 20 cm by 20 cm to 10 cm deep. Transfer sediment to a cleaned stainless steel bowl and cover with aluminum foil.

8. Deploy grab sampler and repeat steps 1, 2, 6, and 7 until enough sediment has been obtained - at least once for sediment chemistry only stations and twice for sediment chemistry and bioassay stations. Approximately 2.3 liters of sediment is needed for chemistry only analyses. About 10 liters of sediment are desired for chemistry and bioassay analyses.

9. Stir the composite sample with a stainless steel spoon until the sample is of uniform color and texture. If material (e.g. twigs, leaves, shells, rocks) needs to be removed it should be noted on the fieldsheet and sampling notes.

- The generation and handling of a flammable hazardous waste in the field.
- The difficult task of providing proper engineering controls under field conditions to avoid worker exposure to toxic chemicals.
- The possibility of contaminating samples (or the environment) with solvent.

As an added measure, when samples are drawn from the grab sample the perimeter sections which have contacted the sides of the sampler will be excluded.

Stainless steel bowls and, utensils will be prepared at the laboratory by a detergent scrub, several rinses in RO water, followed by an acetone rinse with a squirt bottle. They are allowed to air dry and then are wrapped in aluminum foil, which is not removed until used in the field. A clean set of sample handling equipment will be used at each station. After use it will be placed in a covered box for return to the laboratory for cleaning.

New sample containers from the factory will be used for parameters analyzed at the Metro laboratory. Contract laboratories will provide containers prepared by them for the specific parameter.

New disposable nitrile gloves will be provided for technicians handling samples.

Sample Processing

All containers, especially those that will be refrigerated instead of frozen, should be filled so there is no headspace. A headspace of up to ¼ the volume of the container is allowed for samples to be frozen so that water can expand without compromising the container. Sediment grab samples are processed according to the following step-by-step procedure;

1. Bring the grab sampler aboard, place in a plastic tub and inspect for sample acceptability through the top flaps. Measure penetration depth by holding a ruler on the outside edge of the grab and estimating sample height from the bottom of the grab, accounting for the thickness of the metal bottom. Record depth on the fieldsheet and Sample Notes.

minute for sandy sediments and up to 15 minutes for silty sediments. Note the volume of sediment in the graduated cylinder.

19. When these tasks are completed at a station, discard of utensils in a container to be taken back to the laboratory for thorough cleaning.

20. Seal each glass container into a plastic baggie to prevent contamination of other samples if the container breaks. Pack samples to minimize the chances of breaking. Decontaminate the grab sampler and move to the next station.

21. All forms should accompany samples when transported.

22. Excess sediment from the grabs and composite will be placed in a 5 gallon bucket until sampling in an area is complete and then will be dumped back onto site. If a sheen is visible the excess sediment will be covered and transported back to the laboratory for disposal. Note: the excess sediment will be disposed of after analysis. If the data indicates that the sediment should be classified as a hazardous waste, the excess sediment will be sent to a hazardous waste disposal facility. Otherwise it will be disposed of as regular waste.

4.5 CORE PROFILES

Positioning

Coordinates, azimuths and distances for the two core stations are determined in advance. The approximate state plane coordinates of each station are derived from figure 5 which was produced by a computer-aided design program that has the ability to pinpoint locations according to state-plane coordinates. The shore reference station and backsite reference points are surveyed positions with known coordinates. The angle(azimuth) and distance from the shore reference station to the sampling stations and backsite are calculated and converted to hours, minutes and seconds for use in the field. All backsites and reference points are verified in the field prior to sampling.

On the day of sampling, a Sokkisha electronic total station (combined theodolite and infra-red electronic distance-measuring instrument (EDMI)) is manned at the shore

10. If bioassays will be conducted on this composite sample, use a utensil to fill (leave headspace) the 125 ml glass container for methyl mercury. Screw cap on tightly and place in ice chest.

11. Use a stainless steel spatula or spoon to fill (leave headspace) a 100 ml container for metals analysis. Screw cap on tightly and place in ice chest.

12. Use a stainless steel utensil to fill (leave headspace) a 500 ml glass jar for organotin (tributyltin) analysis. Screw cap on tightly and place in ice chest.

13. Use a stainless steel utensil to fill (leave headspace) a 500 ml glass jar for BNA/Pesticides/PCB's analyses. At the laboratory a subsample of this may be used for the enhanced analysis of chlorinated benzenes. This sample size allows for the additional analysis. Screw cap on tightly and place in ice chest.

14. Use a stainless steel utensil to fill (leave headspace) a 100 ml container for analysis of percent solids and total organic carbon. Screw cap on tightly and place in ice chest.

15. Use a stainless steel utensil to fill a 1 l glass jar for particle size distribution characterization. Screw cap on tightly and place in ice chest.

16. If bioassays will be conducted on this composite sample, fill a 500 ml container for determination of interstitial salinity. Screw cap on tightly and store in ice chest.

17. If bioassays will be conducted on this composite sample, fill a plastic bag with 7 liters of sediment and place it in a large bucket. The contract laboratory will divide the sediment sample into appropriate quantities.

18. If bioassays will be conducted on this sample, collect 50 ml of sediment with a marked beaker. Wash the sediment on a 0.063 millimeter mesh sieve until the water passing the sieve is clear. Carefully rinse the retained material into a 100 ml graduated cylinder and allow to settle until the supernatant is clear. Wait until a clear delineation between floc and supernatant water can be seen; roughly 1

not been used for cores this deep, but may be successful since the sediments are suspected to be silts and clays.

Pneumatic roto-hammer

The diver operates this hammer that rotates and pushes on the tube simultaneously. This method has been successful penetrating deep but is ineffective if sand is present.

Pneumatic jackhammer

Similar to the roto-hammer, the jackhammer pounds on the tube. This method penetrates sand, silt and clay, but requires patience to avoid disturbing the sample and may not capture silts and clays lying under sands.

Regardless of the coring method used, when the core tube is considered deep enough a rubber screw plug is inserted into the top of the core tube. A 3/4-inch diameter rope is tied to the top of the core tube by the diver. The survey vessel crew uses a capstan to apply a constant pull to slowly lift the core out of the sediments. Once the core is free of the bottom, the dive inserts another plug into the bottom of the core. Finally, the core is slowly brought onboard the survey vessel.

Sample Acceptability Criteria

As the core is brought aboard it is visually evaluated for release of sediment. This is particularly important if a core plug falls out while the core is being lifted.

Aboard the vessel, the top plug is removed and a yard stick is inserted down the core tube to locate the top of the sediments. The longest core from each station is chosen as the primary core to be analyzed. The second core is archived to serve as a backup in case problems such as excessive disturbance are discovered during the core cutting and splitting procedure. The core length is 3 ft longer than the sample needed at the station. The sediment surface should be less than 3 ft from the top of the core tube.

Overlying water should be present but should not be excessively turbid.

reference station (DIA013). Temporary shore reference stations may be established if obstacles such as barges are encountered. The EDMI targets in on an Omni 360 degree prism cluster mounted on the survey vessel. The survey vessel is directed by the shore-based surveyors to within ±3 m of a sampling station and a buoy is deployed from near where the target prism is mounted.

Once both buoys are deployed, the survey vessel and diver support skiff will anchor alongside a buoy by setting bow and stern anchors. Then the diver proceeds to collect 2 cores at each station. The shore-based surveyor notes the position of the boat when the diver proceeds to the bottom. The surveyor confirms the position for subsequent cores at the station.

Depths are referenced to MLLW with corrections from a staff gauge installed at the Diagonal Way CSO. Measured ranges and angles are converted to and stored on a database as horizontal state-plane coordinates referenced to the Washington coordinate system, north zone, 1983 North American Datum (NAD83).

Coring Operation

Cores are collected by Metro researchers and contracted scuba divers aboard a survey vessel and/or a diver support skiff. The scuba diver operates with a surface air supply and is in constant contact with the skiff via closed circuit radio. Two cores are collected from each station; one is used for analysis while the other is archived. The core farthest offshore is driven six feet into the bottom to ensure that three feet of sediment are retained in the core tube. The upper three feet of the sediment is divided into six sections (figure 7a), all of which are analyzed. The nearshore cores are driven into the bottom nine feet and divided into thirteen sections, nine of which will be analyzed, as described in chapter 3 and shown in figure 7b.

The core is a 4 inch outside diameter, thin-walled aluminum tube equipped with a core catcher. Three similar methods are being considered to drive the core;

Slide Hammer

The driving force is supplied by an underwater version of a metal fencepost driver. The diver bangs a weight up and down until the desired depth is achieved. This type has

Fieldsheets

The following products will be included on all fieldsheets used at sediment stations.

- Sample Number: Unique alpha-numeric number assigned by the Metro laboratory that identifies a section from a core. This number is used throughout the analysis and reporting stages.

- Locator: Project- and site-specific alpha-numeric code used to identify stations. The first three digits (DUD) identify the site, followed by three digits used to identify specific stations within the site. The next eight digits of the code (e.g., 8920/7130) represent the last four digits of the northings and eastings, respectively, rounded to the nearest 10 ft (3 m). The last two digits represent the North American Datum that the northings and eastings are based on.

- Short Locator Description: Project-specific description of the site and station number. May also be used to indicate which section of the core the sample represents.

- Locator Description: Expanded version of the Short Locator Description with the site name, type of sampler, section depth and station.

- Site: General description of the body of water where samples are from, in this case it will be "Duwamish River".

- Collect date: Year, Month and Day sample was collected, expressed as YYMMDD.

- Time: Time of day at which sample is collected, expressed in local military time.

- Sample Depth: Water depth as recorded by an echo-sounder.

- Tide Height: Estimate of the present height of the tide relative to MLLW. Estimate obtained by reading a staff gauge established within viewing range of the vessel or shore-based surveyor.

Sample Documentation

The same field Chain of Custody (COC) procedures described under the storm water collection apply to the collection of sediment samples. Please refer to the Field Documentation portion of section 4.1.

Metro's COC procedures begin with the creation of fieldsheets with preassigned "products" (e.g., sample numbers, locators, location descriptions, and parameters to be analyzed). Fieldsheet products are described below and an example is included in section 4.4. Core samples are discrete samples, instead of composites like those for surface grabs. However, each core section is a different sample. Each section from a core is assigned a unique number that will be used to identify the sample for all field, laboratory and reporting purposes. In other words, subsamples (i.e., for specific parameters) from a specific section of a core sample have the same sample number.

Based on the fieldsheets, sample containers are labeled with preprinted sample labels with station and sample information plus the parameter(s) that container contents are intended for.

A Laboratory Work Order form is the COC form that accompanies samples throughout analysis. This form tracks transfers of sample custody between field personell, to and within Metro's Environmental Laboratory, and to contract laboratories.

The project manager maintains notes about the station position, characteristics of the sediment and sample quality of each individual core taken. This information is stored in a logbook and/or a standard format like the included Sampling Notes form.

Samples will be kept onboard in ice chests and secured with custody tape. Unused core sections will be secured vertically out of the sun until they can be transported to the laboratory for freezing. The samples and accompanying forms will be transported to Metro's laboratory by the end of the day and stored according to proper holding procedures described under laboratory protocols (see table 10).

- Date Sampled: Same as Collect Date on fieldsheet
- Time: Same as Time on the fieldsheet
- Matrix: Same as Matrix on the fieldsheet
- Metro LIMS No.: Same as Sample Number on the fieldsheet

Sampling Notes

The sampling notes are intended as reference notes for the project manager and other personnel. They are not part of the COC procedures, and do not accompany the samples to the laboratory. Instead, the project manager will keep the notes for future reference and they will be provided as an appendix to the Cleanup Study Report. Measurements and notes made in the sampling notes will be used to record qualitative observations in the field and verify information on the database. An example of a sampling notes form is included in section 4.4.

Sample Containers

A 15 cm. (6 in.) long section from a 10 cm. (4 in.) diameter tube will yield almost 1.2 liters of sediment. However, a portion needs to be excluded at each end and where the sediment comes into contact with the core tube. The most that can be excluded and still provide a sufficient amount for all analyses is ½ cm.. In order to run the necessary tests, less volume is being requested for core subsamples than for grab subsamples. Despite the lower volume, detection limits and QA/QC requirements will still be met. However, there may not be enough sediment for archiving or retesting.

The following is a list of the parameters, preferred storage conditions, container volume and type. Freezing of samples will not be possible in the field, so all samples will be stored in ice chests with ice until delivered to the laboratory at the end of the day.

- Sediment Depth: The depth to which the sampler penetrated the sediment.
- Sample Recovery: Estimate of the depth of sample recovered from a sampler. This will likely differ from the Sediment Depth because up to three feet of the core section is not to be processed and analyzed unless necessary.
- Comments: Details that may not be available in other products.
- Personnel: Initials of people onboard and divers collecting cores.
- Sample Method: Five digit numeric code used by Metro's Environmental Laboratory to identify the gear used for sampling. Code is composed of codes for Sampling Category (e.g., core, grab, autosampler), Sampler Type (e.g., van Veen), and Sampler Usage (i.e. accepted methodology). A description of the coding heirarchy and list of methods is provided in Appendix A.
- Sediment Type: Five character alpha-numeric code used to estimate principal and secondary particle size fractions, debris in the sample, sample color and odors. A list of code characters is provided in Appendix A.
- Department, Matrix, Product; This identifies which parameters will be analyzed for from that sample. Department is a one digit number representing the laboratory responsible for analysis (e.g., Conventionals, Metals, Organics). Matrix is the type of material (i.e., marine sediment is SALTWTRSED, storm drain water is STORM WTR). Products are the parameters to be analyzed for, and helps identify the types of sample containers needed.

Laboratory Work Order

The Laboratory Work Order (LWO) form has the necessary identifiers for tracking samples. Three copies of each LWO are produced: two are used for the laboratory COC and one is given to the project manager for recordkeeping. A LWO is filled out in the field as samples are collected and is kept with samples through transfers, storage and analysis. Additional LWO's may be generated as the samples are sent to contract laboratories and sections within Metro's Environmental Laboratory, but the following identifying information will not change.

- Client Sample ID: A number assigned by the Metro lab to the project

New disposable nitrile gloves will be provided for technicians handling samples.

Sample Processing

Process the core samples in the following manner:

1. Bring the core tube onboard. Remove the top plug and a lower a yard stick slowly into the tube until it meets the sediment surface. Assuming that the core tube is filled to the bottom where the core catcher is, calculate the Core Depth (CD0(amount of sediment present) as follows:

   $$(TL - CC) - D = CD$$

   where TL is the core tube length, CC is the distance between the core catcher and the bottom of the tube, and D is the distance from the top of the core tube to the top of the sediment.

2. Record the core depth on the fieldsheet and sampling notes. Write the core depth, station number, and arrows indicating "up" on the core tube with an indelible marker.

3. Insert a siphon hose to drain away excess water above the sediments.

4. Replace the top plug and secure the tube vertically out of the sun.

5. Obtain a second core at the station. Repeat steps 1, 2, 3 and 4 for the second core.

6. Chose the core with the largest core depth as the primary core. Mark the primary core "#1" and the secondary core "#2". Secure both vertically out of the sun until processing can proceed.

7. Place the primary core from a station on a table horizontally. Remove the end caps and allow the remaining water to drain out.

8. Starting from the top of the sediment, divide and mark the outside of the core tube into 15 cm (6 in.) sections on the top 1 m (3 ft.) and into 30 cm (1 ft) sections between 1 m and 2 m. Cut the cores around the circumference at these marked intervals with a manual pipe cutter or, if

TABLE 2: SEDIMENT CONTAINERS AND STORAGE CONDITIONS FOR CORE SAMPLES

Parameter	Storage conditions	Container Volume	Container type
AVS	4°c	(2) 60 ml vials	Glass vials
% Solids & TOC	Freeze, -18°c	100 ml	Plastic
PSD	4°c	250 ml	Glass
Metals	Freeze, -18°c	100 ml	Polyethylene
Mercury	Freeze, -18°c	From metals container	Polyethylene
Organics	Freeze, -18°c	250 ml	Glass/teflon lid

Sampler Decontamination and Container Cleaning Procedures

Sample contamination must be avoided during sample collection. All sampling equipment, sample containers, utensils, instruments, working surfaces and other items that may come in contact with the sediment should be made of a noncontaminating material (e.g., glass, stainless steel, PTFE plastic) and cleansed properly prior to use.

The core tubes will be cleaned prior to sampling with the following procedure:

1. Soap (detergent 8) and water scrub with a long brush
2. Triple rinse with tap water

At the site, the tubes will be thoroughly rinsed in-stream.

Stainless steel bowls, trays and utensils will be prepared at the laboratory by a detergent scrub, several rinses in RO (reverse osmosis) water, followed by an acetone rinse with a squirt bottle. They are allowed to air dry and then are wrapped in aluminum foil, which is not removed until used in the field. A clean set of sample handling equipment will be used for each core section. After use they will be placed in a covered box and returned to the laboratory for cleaning.

New sample containers from the factory will be used for parameters analyzed at the Metro laboratory. Contract laboratories will provide containers prepared by them for the specific parameter.

mixture until homogenous. Transfer the remaining sediment to a 250 ml glass container for particle size distribution analysis. Screw cap on tightly and place in ice chest.

18. When these tasks are completed for this section of the core, discard of utensils and glassware in containers to be taken back to the laboratory for thorough cleaning. The empty core tube sections are taken back to the laboratory to be given to a commercial recycler.

19. Replace the caps on the filled section of core that is not being processed. This short remnant of the primary core and the full length secondary core are taken to the laboratory and stored in case more analysis is determined necessary.

20. Place COC forms with samples for transport to the laboratory.

necessary, a Skil-saw equipped with a carbide tip saw blade. . Secure the core tube with remaining sediment horizontally for further processing.

9. Extrude sample sections by tilting the core section and letting the sediment slide out slowly. If necessary, a clean, fabricated stainless steel plunger can be used to coerce the sediment out into a stainless steel bowl or tray. If possible the sample should lay in the container lengthwise

10. Note stratification of color or texture on the fieldsheet and sampling notes.

11. Exclude the sediment in contact with the edges of the core tube by peeling or scraping off a layer of sediment, approximately 0.5 cm in depth, around the exposed circumference of the sample. Slice 0.5 cm of sediment off each end of the section that may have been in contact with the pipe cutter.

12. Use a stainless steel spoon or spatula to scrape 120 ml of sediment from the entire length of the sample. Transfer this sediment to 2 60 ml glass vials for analysis of AVS, leaving no headspace. Screw cap on tightly and place in ice chest.

13. Transfer the remaining sample, excluding the portion at the bottom that may have been in contact with the core tube to a glass bowl and stir with a spoon or spatula until the sample is of uniform color and texture. Remove and note material (e.g., twigs, leaves, rocks, shells) on the fieldsheet and sampling notes.

14. Use the stainless steel utensil to fill (leave headspace) a 250 ml glass container for analysis of BNA extractables, pesticides and PCB's. Screw cap on tightly and place in ice chest.

15. Use the stainless steel utensil to fill (leave headspace) a 100 ml plastic container for metals analysis. Screw cap on tightly and place in ice chest.

16. Use the stainless steel utensil to fill (leave headspace) a 100 ml glass container for conventionals analyses (TOC and %solids). Screw cap on tightly and place in ice chest.

17. If the scrapings from the sample perimeter are of the same texture as the composite, they may be mixed with the remaining sample. Stir the

Sample Handling

Storm water samples are divided into aliquots upon return from the field. These aliquots need to be preserved and stored according to the following table:

TABLE 3: STORM WATER SAMPLE CONTAINERS AND HOLDING MEASURES

Parameter	Sample Container	Storage Conditions	Sample Preservative	Hold Time
Metals	500 ml plastic	room temp.	nitric acid	6 months
Mercury	from metals container	room temp.	nitric acid	28 days
BNA	1 l glass/Teflon lid	4°C	none	7 days to extract 40 days to analyze
Pest/PCB	1 l glass/Teflon lid	4°C	none	7 days to extract 40 days to analyze
Volatile Organics	40 ml VOA vial	4°C	sodium thiosulfate	7 days
pH	1 l plastic	4°C	none	analyze on receipt
Total suspended solids	included with pH	4°C	none	7 days
Total suspended solids (0.45 micron)	included with pH	4°C	none	7 days

5 ANALYTICAL METHODS

5.1 STORM DRAIN WATER QUALITY ANALYTICAL PROTOCOLS

Laboratory Chain of Custody

Chain of Custody records will be maintained for all samples. These records will document the following information:

- sample identification number
- date and time samples were collected, as well as name of sampler
- location and conditions of sample storage
- date and time of any transfer of possession or change in location

Note that for many samples additional chain of custody records will begin with the sample splitting step. In this case, records will be maintained for both the original sample and subsequent subsamples.

Samples will be transferred to subcontracting laboratories under chain of custody conditions. These conditions will be maintained throughout the analyses.

Trace Metals Analyses

Samples will be analyzed by EPA-approved methods using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP) for all priority pollutants metals except mercury which will be analyzed by Cold Vapor Atomic Absorption Spectroscopy (CVAA). When the metal concentration is below the Reporting Detection Limit (RDL) of the ICP, analysis will be done using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) Hardness will be calculated using ICP results for calcium and magnesium.

TABLE 4: TRACE METALS DETECTION LIMITS FOR STORM WATER

Element	ICP MDL (mg/L)	ICP-MS MDL (mg/L)	CVAA MDL (mg/L)
Antimony	0.03	0.0005	
Arsenic	0.05	0.0005	
Beryllium	0.001	0.0005	
Cadmium	0.003	0.0002	
Calcium	0.05	0.02	
Chromium	0.005	0.0005	
Copper	0.004	0.0005	
Lead	0.03	0.0005	
Magnesium	0.030	0.02	
Nickel	0.02	0.0005	
Selenium	0.05	0.001	
Silver	0.004	0.0003	
Thallium	0.2	0.0005	
Zinc	0.005	0.0005	
Mercury			0.0002

Organics

The table (table 5) on the following pages lists the EPA reference methods and the associated parameters that each method comprises along with the parameter's Method Detection Limit (MDL) and Reporting Detection Limit (RDL) for both water and soils.

EPA Method 8260; Volatile Organic Compounds by GC/MS determines a number of purgeable organic compounds from water or soil matrices. The method also allows for the tentative identification (TICs) and quantitation of compounds not specifically referenced in the methods list of targets.

EPA Method 8270; Semivolatile compounds by GC/MS determines a broad range of semivolatile compounds that include polynuclear aromatic hydrocarbons (PAHs), chlorinated hydrocarbons, phthalate esters, nitrosamines, haloethers, aldehydes, pyridines, aromatic nitro compounds, and phenols in soils and waters. The method also allows for the tentative identification (TICs) and quantitation of compounds not specifically referenced in the methods list of targets.

EPA Method 8080, Chlorinated Pesticides and Polychlorinated Biphenyls (PCBs) by Gas Chromatography determines the class of chlorinated pesticides and PCBs using an electron capture detector for soils and waters.

TABLE 5: ORGANICS METHODS AND DETECTION LIMITS FOR STORM WATER

Reference Method Description	Parameter	MDL ug/L	RDL ug/L
EPA 624 (l)	Chloromethane	1	2
SW-846 8260 (s)	Vinyl Chloride	1	2
Volatiles by Purge	Bromomethane	1	2
and Trap GCMS	Chloroethane	1	2
	Trichlorofluoromethane	1	2
	Acrolein	6	10
	1,1-Dichloroethylene	1	2
	Methylene Chloride	6	10
	Acrylonitrile	6	10
	Trans-1,2-Dichloroethylene	1	2
	1,1-Dichloroethane	1	2
	Chloroform	1	2
	1,1,1-Trichloroethane	1	2
	Carbon Tetrachloride	1	2
	Benzene	1	2
	1,2-Dichloroethane	1	2
	1,1,2-Trichloroethylene	1	2
	1,2-Dichloropropane	1	2
	Bromodichloromethane	1	2
	Trans-1,3-Dichloropropene	1	2
	2-Chloroethylvinylether	1	2
	Toluene	1	2
	cis-1,3-Dichloropropene	1	2
	1,1,2-Trichloroethane	1	2
	Tetrachloroethylene	1	2
	Chlorodibromomethane	1	2
	Chlorobenzene	1	2
	Ethylbenzene	1	2
	Bromoform	1	2
	1,1,2,2-Tetrachloroethane	1	2

Reference Method Description	Parameter	MDL ug/L	RDL ug/L
	Acetone	6	10
	Carbon Disulfide	1	2
	Vinyl Acetate	6	10
	2-Butanone (MEK)	6	10
	2-Hexanone	6	10
	4-Methyl-2-Pentanone (MIBK)	6	10
	Total Xylenes	1	2
	Styrene	1	2
EPA 625 (l)	N-Nitrosodimethylamine	4	6
SW-846 8270 (s)	Phenol	4	6
Semi-Volatiles by	Bis(2-Chloroethyl)Ether	0.6	1
GCMS (BNAs)	2-Chlorophenol	2	4
	1,3-Dichlorobenzene	0.6	1
	1,4-Dichlorobenzene	0.6	1
	1,2-Dichlorobenzene	0.6	1
	Bis(2-Chloroisopropyl)Ether	2	4
	N-Nitrosodi-N-Propylamine	1	2
	Hexachloroethane	1	2
	Nitrobenzene	1	2
	Isophorone	1	2
	2-Nitrophenol	1	2
	2,4-Dimethylphenol	1	2
	Bis(2-Chloroethoxy)Methane	1	2
	2,4-Dichlorophenol	1	2
	1,2,4-Trichlorobenzene	0.6	1
	Naphthalene	2	3
	Hexachlorobutadiene	1	2
	4-Chloro-3-Methylphenol	2	4
	Hexachlorocyclopentadiene	1	2

Reference Method Description	Parameter	MDL ug/L	RDL ug/L
	2,4,6-Trichlorophenol	4	8
	2-Chloronaphthalene	0.6	1
	Acenaphthylene	0.6	1
	Dimethyl Phthalate	0.4	0.6
	2,6-Dinitrotoluene	0.4	0.8
	Acenaphthene	0.4	0.8
	2,4-Dinitrophenol	2	4
	4-Nitrophenol	2	4
	2,4-Dinitrotoluene	0.4	0.8
	Fluorene	0.6	1
	Diethyl Phthalate	1	2
	4-Chlorophenyl Phenyl Ether	0.6	1
	4,6-Dinitro-O-Cresol	2	4
	N-Nitrosodiphenylamine	1	2
	1,2-Diphenylhydrazine	2	4
	4-Bromophenyl Phenyl Ether	0.4	0.6
	Hexachlorobenzene	0.6	1
	Pentachlorophenol	1	2
	Phenanthrene	0.6	1
	Anthracene	0.6	1
	Di-N-Butyl Phthalate	2	2
	Fluoranthene	0.6	1.2
	Benzidine	20	48
	Pyrene	0.6	1
	Benzyl Butyl Phthalate	0.6	1
	Benzo(A)Anthracene	0.6	1
	Chrysene	0.6	1
	3,3'-Dichlorobenzidine	1	2
	Bis(2-Ethylhexyl)Phthalate	0.6	1
	Di-N-Octyl Phthalate	0.6	1

Reference Method	Parameter	MDL	RDL
Description		ug/L	ug/L
	Benzo(B)Fluoranthene	2	3
	Benzo(K)Fluoranthene	2	3
	Benzo(A)Pyrene	1	2
	Indeno(1,2,3-Cd)Pyrene	1	2
	Dibenzo(A,H)Anthracene	2	3
	Benzo(G,H,I)Perylene	1	2
	Aniline	2	4
	Benzyl Alcohol	1	2
	2-Methylphenol	1	2
	4-Methylphenol	1	2
	Benzoic Acid	4	6
	4-Chloroaniline	2	4
	2-Methylnaphthalene	2	3
	2,4,5-Trichlorophenol	4	8
	2-Nitroaniline	4	6
	3-Nitroaniline	4	6
	Dibenzofuran	1	2
	4-Nitroaniline	4	6
	Carbazole	1	2
	Coprostanol	4	6
EPA 608 (l)	4,4'-DDD	0.05	0.1
SW-846 8080 (s)	4,4'-DDE	0.05	0.1
Chlorinated Pesticides/PCBs	4,4'-DDT	0.05	0.1
by GC-ECD	Aldrin	0.05	0.1
	Alpha-BHC	0.05	0.1
	Aroclor 1016	0.5	1
	Aroclor 1221	0.5	1
	Aroclor 1232	0.5	1
	Aroclor 1242	0.5	1

Reference Method Description	Parameter	MDL ug/L	RDL ug/L
	Aroclor 1248	0.5	1
	Aroclor 1254	0.5	1
	Aroclor 1260	0.5	1
	Beta-BHC	0.05	0.1
	Chlordane	0.3	0.5
	Delta-BHC	0.05	0.1
	Dieldrin	0.05	0.1
	Endosulfan I	0.05	0.1
	Endosulfan II	0.05	0.1
	Endosulfan Sulfate	0.05	0.1
	Endrin	0.05	0.1
	Endrin Aldehyde	0.05	0.1
	Gamma-BHC (Lindane)	0.05	0.1
	Heptachlor	0.05	0.1
	Heptachlor Epoxide	0.05	0.1
	Methoxychlor	0.3	0.5
	Toxaphene	0.5	1

Conventionals

Samples will be analyzed by the Conventionals section for pH, Total Suspended Solids (TSS), and Total Suspended Solids 0.45 *um* (TSS45) following procedures from Standard Methods for the Examination of Water and Wastewater. The pH will be measured with a pH meter. TSS will be analyzed by filtering the sample through a glass-fiber and drying the filter at 103°C. TSS45 will be analyzed by filtering the sample through a 0.45*um* filter and then drying the filter at 103°C.

TABLE 6: CONVENTIONALS METHODS AND DETECTION LIMITS FOR STORM WATER

Analyte	Method	Method Detection Limit	Reporting Detection Limit
pH	SM 4500-H, B	not applicable	not applicable
Total Suspended Solids	SM 2540-D	0.5 mg/L	1.0 mg/L
Total Suspended Solids, (0.45*um*)	SM 2540-D	0.5 mg/L	1.0 mg/L

5.2 STORM DRAIN QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

Field QA/QC

Field quality assurance samples will be collected during each of the first 3 sampling events to measure any contaminants introduced to the samples through sample collection and handling procedures. If analysis of these blank samples show significant levels of contamination, field quality assurance samples will be collected on subsequent sampling events. If no significant levels of contamination are found, no further field quality assurance samples will be collected. Field quality assurance will consist of a "field sampling blank" for metals and organics analysis.

Field sampling blank: A Quality Control sample collected in the field using laboratory supplied deionized water. Before collecting any samples, this sample should

be collected by processing the laboratory supplied water in the same manner as a sample collected in the field (i.e. run through automated sampler, transferred to the analytical laboratory, poured into sample containers, composited, etc.). This QC sample will be analyzed for metals and organics.

Laboratory QA/QC

Trace Metals

Analyses shall be performed according to analytical procedures specified in the Trace Metals Section of the Environmental Laboratory Quality Assurance Manual.

The following minimum QA/QC analyses are performed routinely with each set of samples during metals analysis.

TABLE 7: STORM WATER METALS ANALYSIS QA/QC

QC Sample	Acceptance Limits
1 Method blank	< Method Detection Limit (MDL)
1 Laboratory Control Sample of known concentration	80-120% Recovery
1 Laboratory duplicate per 20 samples	<20% Relative Percent Difference
1 Matrix spike per 20 samples	80-120% Recovery
1 Spike blank	80-120% Recovery

Instrument Calibration: Instruments are calibrated daily. Check standards are analyzed immediately after calibration and after every 10 samples to monitor instrument performance. The acceptance limit for the check standards are 90-110%.

Organics

Analyses shall be performed according to analytical procedures specified in the Trace Organics Section of the Environmental Laboratory Quality Assurance Manual.

The following minimum QA/QC analyses are performed routinely per batch of samples. A batch is defined as samples that have been extracted at the same time, up to a maximum of 20 samples:

TABLE 8: STORM WATER ORGANICS ANALYSIS QA/QC

QC Sample	Acceptance Limit
1 Method blank	< Method Detection Limit (MDL), exception noted in the ELD QA Manual
1 Matrix spike	See QA/QC summary sheets for specific analysis and matrix.
1 Matrix spike duplicate	same as for matrix spike.
1 Spike blank	same as for matrix spike.

Instrument Calibration: Instruments are initially calibrated with a 5-point curve. Check standards are analyzed every 12 hours or 10 samples, whichever comes first, to monitor instrument performance.

Conventionals

Analyses shall be performed according to analytical procedures specified in the Conventionals Section of the Environmental Laboratory Quality Assurance Manual.

The following minimum QA/QC analyses are performed routinely per batch during conventionals analyses. A batch is defined as 20 samples.

TABLE 9: STORM WATER CONVENTIONALS ANALYSES QA/QC

QC Sample	Acceptance Limits
1 Method blank	< Method Detection Limit (MDL)
1 Laboratory duplicate per 20 samples	<25% Relative Percent Difference

Instrument Calibration: Instruments are calibrated with a 3-point, 4-point, or 5-point curve where appropriate. The acceptance criteria is r = 0.995 or better.

Please note that the above QC is limited by the scope of the method involved and the amount of sample available for analysis. The parameters involved in this project are pH, total suspended solids (TSS), and total suspended solids 0.45 um filter (TSS45). Routine QC for pH analysis includes Laboratory Control Sample and duplicate analyses; method blanks and matrix spikes are inappropriate for this method. Routine QC for TSS and TSS45 analyses includes method blank analysis and duplicate analysis when sufficient volume is available.

Data Reporting

Standard turn-around time is 30 days from receipt of samples. Data will be provided to the Metro Project Manager in a hard copy comprehensive report that includes a Quality Control summary and narrative, and will also be available in electronic formats. The standard electronic format is an Excel spreadsheet.

The report will include location, sampling date, lab ID, parameter, data qualifier, result, units, matrix, reporting basis, Method Detection Limit (MDL) and Reporting Detection Limit (RDL).

5.3 SEDIMENT CHEMISTRY ANALYTICAL PROTOCOLS

Chain of Custody

Chain of Custody records will be maintained for all samples. These records will document the following information:

- sample identification number
- date and time samples were collected, as well as name of sampler
- location and conditions of sample storage
- date and time of any transfer of possession or change in location

Note that for many samples additional chain of custody records will begin with the sample splitting step. This would be true for cores. In this case, records will be maintained for both the core sample and subsequent subsamples.

Samples will be transferred to subcontracting laboratories under chain of custody conditions and these conditions will be maintained throughout the analyses.

Holding Times

Holding times to be observed for this project are shown in table 10. These holding times are based primarily upon guidance issued from Ecology. This guidance originates from the PSDDA Third Annual Review Meeting (ARM).

Hold times are based on sample storage under frozen conditions for those parameters which may be frozen. Hold times are based upon storage at 4°C for those parameters which may not be stored under frozen conditions.

TABLE 10: SAMPLE STORAGE CONDITIONS FOR SEDIMENTS

Parameter	Sample Container	Storage Conditions	Hold Time	Source of storage requirements*
BNA	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	ARM
Pest/PCB	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	ARM
Metals	P	freeze at -18° C	2 years to analyze	ARM
Mercury	P	freeze at -18° C	28 days to analyze	ARM
Methyl Mercury	Glass	freeze at -18° C	28 days to analyze	no guidance available
Acid Volatile Sulfides	G 2 volatile organics vials	refrigerate at 4° C	7 days	ARM sulfide
Particle Size Distribution	G	refrigerate at 4° C	6 months	ARM
Percent Solids	P	freeze at -18° C	6 months to analyze	ARM
Total Organic Carbon	P	freeze at -18° C	6 months to analyze	ARM
Bioassays	G/P bag	Dark, 4° C	14 days	PSEP 91
Tributyltin	G/teflon lid	freeze at -18° C	1 year to extract 40 days to analyze	no guidance available

*ARM = Minutes of Third PSDDA *Annual Review Meeting.* This document summarizes many program/industry hold time standards. Those to be used for this project are listed above.

**Total Sulfide recommended storage/hold conditions have been used for acid volatile sulfides.

P = plastic, G = glass

Note: all samples to be stored frozen when allowed. Samples to be refrigerated at 4 degrees Celsius after thawing

Note: Mercury storage conditions have been used for methyl mercury. Organic semivolatile storage conditions have been used for tributyltin.

Analytical Methodology

Analyses for most metals, organics and conventional parameters will be conducted at the Metro Environmental laboratory. Analyses for the following parameters will be conducted at subcontractor laboratories:

Subcontracted Parameter

- Methyl mercury
- Tributyltin
- Particle Size Distribution
- Acid Volatile Sulfides
- Amphipod Bioassay
- Echinoderm Bioassay
- Polychaete bioassay

When applicable, methodology cited herein is approved by Ecology for the analysis of marine sediments. When applicable, these method citations includes both a preparation and instrumentation method. All Sediment Quality Standards Chemicals of Concern are contained in the Metro target list.

Limits of Detection

Limits of detection are shown in the following tables:

Analyses	Detection Limit Table
Metals	Table 11
Semivolatiles	Table 12, 13
Pesticides/PCBs	Table 14
Conventionals	Table 15
All other tests	Table 16

These tables provide a Method Detection Limit (MDL) and Reporting Detection Limit (RDL) for analyses to be conducted at the Metro lab. The MDL represents the

lowest concentration at which sample results will be provided. The RDL represents the minimum concentration from which method performance becomes quantitative and is not subject to the degree of variation observed at concentrations between the MDL and RDL.

Note that several assumptions have been made in the calculation of detection limits. Typical sample size and method concentration factors have been assumed for all parameters. The tables show detection limits on a dry weight basis. A typical percent solids of 50% has been used to calculate these dry weight detection limits. Note that because the MDL/RDL are based on sample size and percent moisture, slight variation in reported MDL/RDL will be observed. Additionally, listed MDL and RDL are based on typical method concentration factors and may not be attainable in all samples, depending on sample matrix.

Metals Analyses

Methods to be used for the analysis of metals in sediment are listed in table 11. This table includes the metals target list along with typical reporting and detection limits for this study. Detection limits for metals analysis are below Sediment Quality Standards criteria.

TABLE 11; METALS METHODS AND DETECTION LIMITS FOR SEDIMENTS

Metal	METHOD	RDL mg/Kg dry weight	MDL mg/Kg dry weight
Aluminum	3050/6010	100	20
Antimony	3050/6010	30	6
Arsenic	3050/6010	50	10
Beryllium	3050/6010	1.0	0.2
Cadmium	3050/6010	3.0	0.6
Chromium	3050/6010	5.0	1
Copper	3050/6010	4.0	0.8
Iron	3050/6010	50	10
Lead	3050/6010	30	6
Mercury	7471	0.4	0.04
Nickel	3050/6010	20	4
Selenium	3050/6010	50	10
Silver	3050/6010	4.0	0.8
Thallium	3050/6010	200	40
Zinc	3050/6010	5.0	1

EPA Method 3050 utilizes strong acid digestion techniques

EPA Method 6010 utilizes ICP instrumentation

EPA Method 7471 utilizes cold vapor AA techniques

EPA Method 7040 utilizes graphite furnace instrumentation.

Detection Limits are based on a nominal sample weight of 1 gm, final digestate volume of 100 mL and 50 % solids by weight.

Organics Analyses

Tables 12, 13 and 14 list the Metro target compounds and reporting detection limits for this study. Tentatively identified compounds (TIC's) will be reported. These TIC's will be reported on the ten most prominent non-aliphatic compounds.

Base/Neutral/Acid Extractables

The detection limits for all organic parameters listed in table 12 are provided in a dry weight basis. Note that Sediment Management Standards for ionizable organic compounds are also formatted on a dry weight basis. Note, however, that Sediment Management Standards for nonionizable organic compounds are formatted in a TOC normalized basis.

Metro detection limits will meet SMS for all ionizable compounds, with the exception of 2,4 dimethylphenol. As shown in Table 12 Metro can achieve an MDL of 33 ppb for this compound. The SQS standard for this compound is 29 ppb.

Note that summation of individual Metro detection limits will meet Sediment Quality Standards for those criteria which represent totals of other compounds, such as LPAH and HPAH. As further detailed in Table 12, LPAH and HPAH represent totals of individual PAH results.

Ability to achieve the TOC normalized Sediment Quality Standards for nonionizable organic parameters will depend on the TOC concentrations of the sediments. Of note for this project are the TOC normalized detection limits for the chlorinated benzenes. The Metro TOC normalized MDL for chlorinated benzenes are shown in Table 13. The values shown are based on TOC values of 2800 ppm and 10,000 ppm. The 10,000 ppm TOC value is a typical, but low, value for this site. The 2800 ppm value is the lowest value observed in a recently reported series of data from this region of Elliot Bay, and likely represents the lowest value expected for this study.

All samples will be analyzed by Methods 3550/8270. These methods utilize solvent extraction with sonication followed by GC/MS instrumentation.

TABLE12; BNA DETECTION LIMITS (ug/Kg dry weight)

Compound	RDL[a]	MDL[a]	Compound	RDL[a]	MDL[a]
1,2,4-Trichlorobenzene	34	17	Benzo(K)Fluoranthene**	100	50
1,2-Dichlorobenzene	34	17	Benzoic Acid	200	100
1,2-Diphenylhydrazine	134	67	Benzyl Alcohol	66	33
1,3-Dichlorobenzene	34	17	Benzyl Butyl Phthalate	34	17
1,4-Dichlorobenzene	34	17	Bis(2-Chloroethoxy)Methane	66	33
2,4,5-Trichlorophenol	260	130	Bis(2-Chloroethyl)Ether	34	17
2,4,6-Trichlorophenol	260	130	Bis(2-Chloroisopropyl)Ether	134	67
2,4-Dichlorophenol	66	33	Bis(2-Ethylhexyl)Phthalate	34	17
2,4-Dimethylphenol	66	33	Carbazole	66	33
2,4-Dinitrophenol	134	67	Chrysene**	34	17
2,4-Dinitrotoluene	26	13	Coprostanol	200	100
2,6-Dinitrotoluene	26	13	Di-N-Butyl Phthalate	66	33
2-Chloronaphthalene	34	17	Di-N-Octyl Phthalate	34	17
2-Chlorophenol	134	67	Dibenzo(A,H)Anthracene**	100	50
2-Methylnaphthalene	100	50	Dibenzofuran	66	33
2-Methylphenol	66	33	Diethyl Phthalate	66	33
2-Nitroaniline	200	100	Dimethyl Phthalate	20	10
2-Nitrophenol	66	33	Fluoranthene**	40	20
3,3'-Dichlorobenzidine	66	33	Fluorene*	34	17
3-Nitroaniline	200	100	Hexachlorobenzene	34	17
4,6-Dinitro-O-Cresol	134	67	Hexachlorobutadiene	66	33
4-Bromophenyl Phenyl Ether	20	10	Hexachlorocyclopentadiene	66	33
4-Chloro-3-Methylphenol	134	67	Hexachloroethane	66	33
4-Chloroaniline	134	67	Indeno(1,2,3-Cd)Pyrene**	66	33
4-Chlorophenyl Phenyl Ether	34	17	Isophorone	66	33
4-Methylphenol	66	33	N-Nitrosodi-N-Propylamine	66	33
4-Nitroaniline	200	100	N-Nitrosodimethylamine	200	100
4-Nitrophenol	134	67	N-Nitrosodiphenylamine	66	33
Acenaphthene*	26	13	Naphthalene*	100	50
Acenaphthylene*	34	17	Nitrobenzene	66	33
Aniline	134	67	Pentachlorophenol	66	33
Anthracene*	34	17	Phenanthrene*	34	17
Benzidine	1600	800	Phenol	200	100
Benzo(A)Anthracene**	34	17	Pyrene**	34	17
Benzo(A)Pyrene**	66	33	Total HPAH's	740	370
Benzo(B)Fluoranthene**	100	50	Total LPAH's	462	231
Benzo(G,H,I)Perylene**	66	33	Total Benzofluoranthenes	300	150
Benzo(J)Fluoranthene**	100	50			

a Detection Limits are in ug/Kg dry weight

* This compound is a component of the LPAH total.

** This compound is a component of the HPAH total.

Detection Limits are based on routine method concentration factors and 50 % solids by weight.

Chlorinated Benzenes

Chlorinated benzenes will be analyzed using a tiered approach. Initial analyses for these compounds will be conducted using Method 3550/8270. After this initial analysis, normalized results will be calculated and a determination made regarding the acceptability of the analytical results in comparison with SQS standards. Further analyses will be conducted should the TOC normalized MDL exceed SQS standards for chlorinated benzenes.

Note that the Metro lab is in the process of reevaluating, for these compounds, the MDL as shown in Table 13. This reevaluation will also involve the investigation of the Ion Trap detector for the GC/MS. This GC/MS detector will yield lower MDL than the current quadropole and will likely meet SQS TOC normalized MDL. Should this not be the case, further method refinement and development will be conducted to achieve SQS normalized MDL.

TABLE 13: CHLORINATED BENZENE DETECTION LIMITS (MG/KG OC)

Parameter	SQS criteria	Metro MDL based on TOC of 10,000	Metro MDL based on TOC of 2,800
1,2 Dichlorobenzene	2.3	1.7	6.0
1,4 Dichlorobenzene	3.1	1.7	6.0
Hexachlorobenzene	0.38	1.7	6.0
1,2,4 Trichlorobenzene	0.81	1.7	6.0

At the typical TOC value of 10,000 ppm TOC normalized detection limits for all nonionizable compounds except 1,2,4 trichlorobenzene and hexachlorobenzene meet SQS criteria.

TABLE 14; PESTICIDE AND PCB METHODS AND DETECTION LIMITS FOR SEDIMENTS

Compound	Method	RDL ug/Kg dry weight	MDL ug/Kg dry weight
Aroclor 1016	3550/8080	34	17
Aroclor 1221	3550/8080	34	17
Aroclor 1232	3550/8080	34	17
Aroclor 1242	3550/8080	34	17
Aroclor 1248	3550/8080	34	17
Aroclor 1254	3550/8080	34	17
Aroclor 1260	3550/8080	34	17
Total Aroclors	3550/8080	34	17
4,4'-DDD	3550/8080	3.4	1.7
4,4'-DDE	3550/8080	3.4	1.7
4,4'-DDT	3550/8080	3.4	1.7
Aldrin	3550/8080	3.4	1.7
Alpha-BHC	3550/8080	3.4	1.7
Beta-BHC	3550/8080	3.4	1.7
Chlordane	3550/8080	16.6	8.3
Delta-BHC	3550/8080	3.4	1.7
Dieldrin	3550/8080	3.4	1.7
Endosulfan I	3550/8080	3.4	1.7
Endosulfan II	3550/8080	3.4	1.7
Endosulfan Sulfate	3550/8080	3.4	1.7
Endrin	3550/8080	3.4	1.7
Endrin Aldehyde	3550/8080	3.4	1.7
Gamma-BHC (Lindane)	3550/8080	3.4	1.7
Heptachlor	3550/8080	3.4	1.7
Heptachlor Epoxide	3550/8080	3.4	1.7
Methoxychlor	3550/8080	16.6	8.3
Toxaphene	3550/8080	34	17

Method 3550/8080 utilizes solvent extraction with sonicaation and GC/ECD with dual column confirmation.

Detection Limits are based on routine method concentration factors and 50 % solids by weight.

Conventionals

The methods to be employed for the analysis of conventionals are listed in table 15. These methods correspond to available Ecology guidance. Sediment Management Standards are not available for conventional parameters. Conventionals detection limits meet method specified detection limits.

Interstitial Salinity

Interstitial salinity is determined using the following procedure:

- samples are centrifuged to isolate interstitial water
- conductivity and temperature are measured on the interstitial water
- salinity is calculated from the conductivity and temperature

TABLE 15: CONVENTIONALS METHODS AND DETECTION LIMITS FOR SEDIMENTS

Parameter	Method	MDL	RDL
Total Organic Carbon	SM 5310B PSEP prep p.23	0.0002%	0.0006%
Total Solids	SM 2540-B	NA	NA
Particle Size Distribution	PSEP p. 9, ASTM 422	0.1 %	NA
Acid Volatile Sulfides	EPA Dec. 1991, PSEP	6 ppm	NA

MDL and RDL reported on a dry weight basis, using 50 % solids to calculate to a dry weight basis.

Acid Volatile Sulfides (AVS)

This parameter will be performed by a contract laboratory. Samples will be analyzed using Analytical Methods for Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment. This method specifies that samples will be acidified and the sulfide extracted using a purge and trap principle. The sulfide will then be determined using either gravimetric or colorimetric methodology, depending on the sulfide level present in the sample. The gravimetric method is used for high level samples.

Other Subcontracted Analyses

TABLE 16: OTHER ANALYSES METHODS AND DETECTION LIMITS FOR SEDIMENTS

Parameter	Method	MDL	RDL
Tributyltin	see text grignard/FPD-GC	26 ppb	130 ppb
Methyl mercury	see text	10 pg/Kg	NA

Tributyltin

Tributyltin will be analyzed following a method described by the paper "A Method for Analyses of Butlytin Species and Measurement of Butyltins in Sediments and English Sole Livers from Puget Sound". This Method was published in Marine Environmental Research 27 (1989) by NOAA. This method employs grignard reagent and flame photometric detector gas chromatography.

Methyl Mercury

Methyl Mercury will be analyzed with methodology developed and refined by the potential subcontractor. This methodology isolates the methyl mercury from sediment samples by a distallation using water, hydrochloric acid, sulfuric acid and potasium chloride. The methyl mercury is derivitized to methyl ethyl mercury, and analyzed by purge and trap gas chromatography with atomic fluorescence spectrophotometry of the mercury atom used as the detection technique.

Laboratory Reports

Data will be reported in the Metro Environmental Laboratory comprehensive reporting format. This report format includes the following information:

- sample identification, sample location
- analytical result, data qualifier

- MDL and RDL. Data below the MDL will be noted as "<MDL". Values between the MDL and RDL will be reported at the estimated concentration with "<RDL" reported as a qualifier.

Sediment data will be reported on a dry weight basis. Sediment reports include the percent solids and total organic carbon. State plane coordinates and latitude/longitude will also be reported. Sediment Depth and Sediment Recovery will be reported in centimeters.

Data will be reported to the Metro project manager within 45 days of receipt by the laboratory. Data will also be provided on diskette, in an MS EXCEL format. The data report will also include the QA 1 data assessment in hard copy. The electronic data report qualifiers and QA1 data assessment will be in a format compatible with transfers to Ecology.

Data reported from subcontracting laboratories will be accompanied by the associated raw data. This raw data, along with the QC data, will be used to conduct a QA 1 review of the subcontracted parameters.

QA 1 Narrative Contents

Sediment chemistry data will be accompanied by a QA 1 review. The QA review is a discussion of the following topics.

- Scope of Samples Submitted
- Completeness
- Method
- Target List
- Detection Limits
- Holding Conditions and Times
- Method Blank
- Standard Reference Material

- Replicates
- Matrix Spikes
- Data Qualifiers
- Subcontracting
- Units and Significant Figures

Reporting of QC Data for QA1 data submission.

QC data will be reported in the same units as the sample data. Duplicates will be reported as result, duplicate result, RPD. Triplicates will be reported as result, duplicate result, triplicate result, RSD. Matrix Spikes will be reported as sample result, spike added concentration, spike sample result, % recovery.

5.4 SEDIMENT CHEMISTRY QUALITY ASSURANCE/QUALITY CONTROL

The quality control samples listed in table 17 will be analyzed to support data generation activities for this project. The type and frequency of quality control sample in table 17 is based on PSDDA guidelines.

Results from these quality control samples will be used to assess the data according to QA 1 guidelines. Data will then be qualified in accordance with Metro data qualifiers, as shown in Table 18.

TABLE 17: QC SAMPLE FREQUENCY FOR SEDIMENT CHEMISTRY PARAMETERS

Parameter	Blanks	Replicates	Triplicates	Matrix spike	Crm *	Surrogates
BNA	1 per batch	5% minimum, 1/extraction batch	1/batch of > 20 samples	5% minimum, 1/extraction batch	1 per extraction batch	yes
Pest/PCB	1 per batch	5% minimum, 1/extraction batch	1/batch of > 20 samples	5% minimum, 1/extraction batch	1 per extraction batch	yes
Metals	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Mercury	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Mercury Species	1 per batch	5% minimum, 1/batch	NA	5% minimum, 1/batch	1 per batch	NA
Total Organic Carbon	1 per batch	5% minimum, 1/batch	5% minimum, 1/batch	NA	1 per batch	NA
Percent Solids	NA	5% minimum, 1/batch	5% minimum, 1/batch	NA	NA	NA
Particle Size Distribution	NA	10 % of samples	10 % of samples	NA	NA	NA
Acid Volatile Sulfides	1 per batch	10 % of samples	10 % of samples	NA	NA	NA
Methyl Mercury	1 per batch	1 per 20 samples	1 per 20 samples	NA	YES	NA
Tributyltin	1 per batch	NA	NA	MS/MSD per batch	1 blank spike per batch	yes

* Subject to availability. A check standard will be analyzed should a CRM (or certified reference material) not be available.

** It is not possible to spike all pesticide and PCB compounds in to the same sample and obtain useful recovery information. Suspected contaminant target compounds will be used for this spike.

TABLE 18; SUMMARY OF Metro SEDIMENT DATA QUALIFIERS

Condition to Qualify	SEDQUAL Qualifier	Organics QC Limits	Metals QC Limits	Conventionals	Metro Equivalent Qualifier
very low matrix spike recovery	X	< 10 %	< 10 %	NA	X
low matrix spike recovery	G	< 50%	< 75%	NA	G
high matrix spike recovery	L	> 150%	>125%	NA	L
low SRM recovery	G	within 95% window	NA	within 95% window	G
high SRM recovery	L	within 95% window	>120%	within 95% window	L
high duplicate RPD	E	>100 %	>20%	> 20 %	E
high triplicate CV coefficient of variation	E	> 100%	NA	> 20 %	E
less than the reporting detection limit	T	NA	NA	NA	< RDL
less than the method detection limit	U	NA	NA	NA	< MDL
contamination reported in blank	B	present at any concentration	present at any concentration	present at any concentration	B
very biased data, based on surrogate recoveries	X	all fraction surrogates are <10%	NA	NA	X
biased data, based on surrogate recoveries	E	all fraction surrogates are < 50% or >150%	NA	NA	E
estimate based on presumptive evidence	N	NA	NA	NA	J# used to indicate the presence of TIC's
rejected, unuseable for all purposes	R	NA	NA	NA	R

5.5 BIOLOGICAL LABORATORY ANALYTICAL PROTOCOLS

Sample collection and analysis will be conducted in accordance with current Puget Sound Estuary Program protocols and WAC 173 - 204 - 315. Analysis of samples with salinities of > 25 ppt will employ three marine organisms; the amphipod 10 - day mortality test, a larval echinoderm mortality and abnormality test and a juvenile polychaete 20 - day growth test. Analysis of samples with salinities of < 25 ppt will employ the same three organisms and rely on mixing and equilibrating the sediments with seawater prior to testing to achieve sediment interstitial salinities that are > 25 ppt and acceptable to these organisms. Twelve samples will be collected for toxicity testing at the Duwamish/Diagonal site and two reference samples will be collected at Carr Inlet.

Biological Analyses

The following table identifies the suggested test organisms based on the recommendations in PSEP (1994). The sample locations and corresponding salinity values refer to preliminary sampling carried out to assess the salinity of interstitial water at various collection points at the site. Results indicate that about one-half of the samples collected can be expected to have interstitial water salinities of slightly less than 25 ppt.

TABLE 19: TOXICITY TESTS FOR SEDIMENTS

Sample Locations	Salinity, ppt	Test Organisms	Test Type	PSEP 1994
DD 1 and 2	21.3 - 23.0	Amphipod *Rhepoxynius abronius*	10-day mortality	pp. 20 - 29
DD 1 and 2	21.3 - 23.0	Echinoderm *Dendraster excentricus*	mortality / abnormality	pp. 39 - 47
DD 1 and 2	21.3 - 23.0	Polychaete *Neanthes sp.*	20-day growth	pp. 63 - 76
DD 3 and 4	31.8 - 33.3	Amphipod *Rhepoxynius abronius*	10-day mortality	pp. 20 - 29
DD 3 and 4	31.8 - 33.3	Echinoderm *Dendraster excentricus*	mortality / abnormality	pp. 39 - 47
DD 3 and 4	31.8 - 33.3	Polychaete *Neanthes sp.*	20-day growth	pp. 63 - 76

Overview of Sediment Toxicity Tests

Amphipod

The amphipod sediment toxicity test is a 10-day acute test used to determine the influence of experimental sediments on survival of *Rhepoxynius abronius*. *Rhepoxynius abronius* amphipods are collected by Beak personnel from the West Beach area of Whidbey Island. Upon arrival in the laboratory, the amphipods are acclimated to the test temperature in their native sediments and then introduced to the sediment-loaded test vessels which are aerated during the test. Seawater used in the acclimation and testing is filtered, UV-sterilized marine water from the National Marine Fisheries Service (NMFS) Laboratory at Mukilteo, Washington. Each test is run with the appropriate negative (West Beach sand) and positive (cadmium chloride) controls. Test vessels are inspected daily for the emergence of amphipods from sediments to determine the number of organisms that refuse to re-bury. Positive controls are also inspected daily and are terminated after four days, at which time survivorship in each concentration is determined. After 10 days, control and experimental sediments are sifted, and surviving individuals are gently removed and counted. Percent reburial of test amphipods in clean sediment will also be determined at test termination. Statistical comparisons of amphipod survival are made between negative controls and test vessels containing reference and experimental sediments. All information concerning test conditions and environments, positive and negative controls, reference and experimental sediments is included in the final report.

Echinoderm

The echinoderm embryo sediment toxicity test is a 48- to 96-hour mortality/abnormal development test used to determine the influence of experimental sediments on development of the echinoderm embryo. Adult sand dollars (*Dendraster excentricus)* will be spawned with the resultant embryos used for these tests. Sand dollars will be collected by Beak personnel from Kopachuck State Park, an uncontaminated site located in Carr Inlet. Upon arrival in the laboratory, adult sand dollars are acclimated to test temperature and then chemically induced to spawn. Eggs are fertilized at the appropriate concentration, and the resultant embryos are introduced into prepared test vessels. Seawater used in acclimation and testing is from the NMFS facility at Mukilteo, Washington. Each test is run with the appropriate negative (seawater) and positive (cadmium chloride) controls. Replicate test vessels are monitored daily

for water quality. The test is terminated when 95 % or more of the larvae reach the four-armed pluteus stage. The test is terminated by addition of 5 % buffered formalin to well-mixed aliquots from each vessel. Determination of development stage is made microscopically. Statistical comparisons of embryo development are made between vessels from the reference and experimental sediments. All information concerning test conditions and environments, positive and negative controls, and experimental sediments is included in the final report.

Polychaete

The juvenile polychaete sediment toxicity test is a 20-day chronic/sublethal test used to determine the influence of experimental sediments on survival and growth. Juvenile polychaetes (*Neanthes* sp.) are purchased from Dr. Don Reisch, California State University, Long Beach, for use in this test. Upon arrival, worms are acclimated to the test temperature and then placed in the sediment-loaded vessels. Seawater used in acclimation and testing is from the NMFS facility at Mukilteo. Each test is run with the appropriate negative (West Beach sand) and positive (cadmium chloride) controls. The feeding and overlying seawater renewal schedule is specified in PSEP. Positive controls are not fed and are terminated after four days, at which time the survivorship at each concentration is determined. Water quality of overlying seawater in negative control, reference and experimental sediment vessels is determined on the same schedule as the water renewal. After 20 days, control, reference and experimental sediments are sifted and surviving individuals are gently removed from their larval tubes, rinsed and dried to a constant weight at 50 ° C. Statistical comparisons of worm survival, biomass and growth are made between reference and the experimental sediments. All information concerning test conditions and environments, positive and negative controls, and experimental sediments is included in the final report.

In addition to the biomass endpoint specified by SMS, individual estimated growth rate, an endpoint recently adopted by the PSDDA program, will be calculated with the following formula:

$$G = (DW_t - DW_i) \div T$$

where

G =		estimated individual growth rate (mg dry wt./day)
DW_t =		estimated ind. dry weight at test termination (mg)
DW_i =		est. ind. dry weight at test initiation (mg)
T =		exposure time (days)

Testing Laboratory

Beak Consultants Incorporated will collect organisms and negative control sediments, and conduct the laboratory bioassay analyses. Metro will collect the reference and test sediments..

Sample Storage for Biological Analyses

The following table contains sample storage criteria for all samples collected for toxicity testing. Preservatives are not used.

TABLE 20: SEDIMENT TOXICITY TESTS STORAGE REQUIREMENTS

Test	Hold Time	Sample Size	Temperature ° C	Container
Amphipod	14 days	3 L	4 (dark)	Plastic bag
Echinoderm	14 days	1 L	4 (dark)	Plastic bag
Polychaete	14 days	3 L	4 (dark)	Plastic bag

General Requirements for Sediment Toxicity Tests.

These requirements are provided as an overview only and are not complete. Specific requirements for each test are found in PSEP (1994) guidelines and provide the primary reference for conducting the tests.

a) Samples are stored in the dark at 4 ° C for a maximum of 14 days.

b) Tests will include negative (nontoxic) controls, in replicate, using West Beach sand.

c) Reference sediments of similar sediment texture will be collected from Carr Inlet

d) Control and reference sediments will be from areas known to be free of anthropogenic impacts, or will be tested and compared to the SMS requirements

e) A control of seawater is used in the echinoderm test.

f) Every test will include a concurrent positive (toxic) control using a 5-dilution geometric concentration series for the reference toxicant $CdCl_2$. The positive control test is designed and conducted so as to achieve an LC50.

g) Only healthy organisms of similar size and life stage are used.

h) Blind testing will be done on samples. Replicates should be randomized in the test sequence and assigned a code number.

i) Water quality is maintained within acceptable limits throughout the test period. The following will be measured daily: salinity, dissolved oxygen, pH and temperature. Ammonia and sulfides will be measured at the beginning and end of each test.

j) Standard laboratory procedures are followed in all testing, including proper documentation, proper cleaning, avoidance of contamination and maintenance of appropriate test conditions.

k) Test sediments with interstitial salinities <25‰ will be equilibrated with seawater from an approved site to adjust sediment interstitial salinity to >25‰.

Test Acceptance Criteria and Statistical Analyses

The following performance criteria are recommended for acceptance of bioassay test data. These criteria are taken directly from the Sediment Management Standards (WAC 173-204-315(2)).

Organism/Test	Negative Control	Reference Sediment
Amphipod 10-day Survival	Mean mortality < 10%	Reference mortality < 25%
Echinoderm Embryo Survival/Abnormality	# normal survivors/ initial count > 0.5	No criteria presented
Juvenile Polychaete 21 day Survival and Growth	Mean mortality < 10%	Reference mean ind. wt./control mean ind. wt >= 0.8

Reference sediments are collected from Carr Inlet with the intent of helping to separate grain size impacts from toxicity impacts. There will be variability in reference sediment results since sediments in Carr Inlet will not be uniform; this variability is beyond the laboratory's control. Therefore, Beak and Metro must note the results of the reference sediment test as it progresses and initiate discussions with Ecology as soon as possible if the results might impair the test's acceptability.

Negative control sediments from West Beach are "clean" sediments providing a comparative test to evaluate the usefulness of reference sediment results in the statistical analysis of test sediments. The criteria for test acceptability are thus strongly linked to these controls. Like

reference sediments, the same care in watching results as they progress and communicating concerns to Ecology are necessary to reduce the risk of retesting.

Positive controls are test series run with reference toxicants in seawater without sediment with the intent of helping to define the "health" or viability and the sensitivity of the test organisms. As positive control tests terminate earlier than the complete test for the Amphipod and Juvenile Polychaete test, this will provide early indication as to the eventual acceptability of these tests to the regulatory agency. Like reference and negative control sediments, the progress must be monitored and concerns communicated to Ecology.

If retesting is necessary the following considerations are paramount:

1. Initiate testing as early as possible to allow sufficient time to retest without collecting additional samples.
2. Identify and correct the most probable reason for acceptability failure. This may include a change in organism supply, recollection of reference sediment, or other action.

Results from each sample will be compared statistically to the reference sediment. In accordance with Ecology regulations, the data will be interpreted by standard t-test after an arcsine transformation for percentile data. In addition, data is first tested for normality (Shapiro-Wilk's Test) and homogeneity of variance (Bartlett's Test). If possible, non-normal and/or heterogenous data is corrected by an appropriate transformation. The data is then analyzed by the t-test indicated in the table below:

Normal?	Homogenous?	Equal Reps?	Statistical Test to Use
Y	Y	Y	Dunnett's T-test
Y	Y	N	T-test with Bonferroni adjustment
N	N/Y	Y	Steel's Many-One Rank Test
N/Y	N	Y	Steel's Many-One Rank Test
N	N/Y	N	Wilcoxon Rank Sum w/ Bonferroni Adjustment
N/Y	N	N	

Laboratory Reports

The contract lab will provide written reports documenting all sample analyses, and as a minimum should include:

- COC procedures and any deviations from the procedures
- Summary of protocols implemented during analysis and an account of any deviations from the protocols
- Tabulated bioassay and QC results
- Results of water quality monitoring
- Results for all the QA/QC checks initiated by the lab

Data reporting requirements are given in PSEP 1994. The following is a summary of the minimum measurements and endpoints that will be reported;

a. Water quality
   Daily: Dissolved oxygen, pH, salinity, temperature
   Beginning and end of test: Ammonia and sulfides

b. Field or laboratory tests
   pH, redox potential and temperature with field instruments
   Interstitial Salinity for control, reference and test sediments

c. Amphipod
   10-day mortality and the mean and standard deviation for each treatment
   Daily emergence and failure to rebury after 10 days
   96-hour LC_{50} values with reference toxicants

d. Echinoderm
   Individual replicate and mean and standard deviation for percent mortality and abnormality at termination of bioassay
   LC_{50} values for reference toxicants

e. Polychaete
   Survival after 20-day exposure

Total and average individual biomass, and the mean and standard deviation of both biomass measurements for each treatment
Individual estimated growth rate, as described above
96-hour LC_{50} values with reference toxicants

5.6 BIOLOGICAL LABORATORY QA/QC

Beak is an Ecology certified laboratory for the three bioassay protocols. Conventional chemical analyses that will be provided for the negative control sediment will be performed by AMTest Inc., an Ecology certified analytical laboratory.

A Chain of Custody (COC) outline is to be provided by the testing laboratory and will include:

- Sample identification numbers
- Person, date and time of sample receipt
- Analytical measurements required
- Location and conditions of storage
- Date and time of removal from, and return to, storage
- Signature of person removing and returning the samples
- Reason for removal from storage

QC procedures including negative and positive controls are contained in each method referenced.

Beak's Quality Assurance program includes a regular, ongoing series of maintenance and calibration of laboratory equipment and bioassay organisms. The laboratory includes areas designated for culturing, sample storage, sample processing and toxicity testing. Beak's project manager, Dr. Charles Wisdom, will ensure that this study is executed according to the appropriate PSEP protocols and ensures compliance with QA/QC procedures. Project records are regularly updated by the project manager with respect to findings, schedule and budget.

Project records include an outline of the study background, study design and methodology, testing dates and conditions, test results, statistical procedures employed and any circumstances that may have affected data quality or study integrity. All reports will be signed and dated by the project manager and reviewed by a quality assurance officer prior to submission.

APPENDIX A

1. Sampling Methodology Categories
2. Sediment Type Code

Code	Sampling Methods Description
13033	Well sampling, teflon, gas-driven, dedicated bladder pump
13052	Well sampling, polyethylene, gas-driven, portable bladder pump
13053	Well sampling, polyethylene, gas-driven, dedicated bladder pump
13101	Well sampling, bailer, hand-lowered
20011	Sediment grab, Ekman, hand-held, hand-lowered
20012	Sediment grab, Ekman, shipboard, lowered by hydrowire
20032	Sediment grab, single Van Veen, shipboard, lowered by hydrowire
20042	Sediment grab, Van Veen-in-tandem, shipboard, lowered by hydrowire
24010	Benthos sampler, artificial substrate
25010	Sediment/Solids grab, manual, shovel/trowel
25020	Sediment/Solids grab, manual, clippers/shears
25030	Sediment/Solids grab, manual hand grab
27010	Shellfish collection, manual, shovel/trowel
30010	Sediment coring device, gravity corer
30020	Sediment coring device, piston corer
30030	Sediment coring device, box corer
30040	Sediment coring device, hand-held corer
30050	Sediment coring device, diver-operated
32000	Sediment bottom dredge
40011	Benthos, Serber net for freshwater, hand-held and operated
41021	Crayfish trap, wood box, hand-lowered
41031	Crayfish trap, wire shrimp trap, hand-lowered
41050	Fish trap
41100	Crab trap
41300	Otter trawl
41350	Try net
41500	Rodent trap, steel
42000	Plankton net
43000	Net, hand-held
46010	Particulate filtering, Large-volume Particulate Sampler
46050	Particulate filtering, two-piece pressurized filter holder
49010	Solids collection, dry vacuum, street vacuum
50010	Accumulator, deposition sample collector, sediment trap
52000	Accumulator, precipitation gauge
55011	Respiration, CO2, soda-lime method, 24-hr composite (soil)
60010	Multiple sensor sys, CTD
60101	Multiple sensor sys, U-7 portable, hand-held
60201	Multiple sensor sys, Hydrolab portable, hand-held
62010	Single-parameter sensor, portable, conductivity
62020	Single-parameter sensor, portable, temperature

4-11-94

SAMPLING METHODOLOGY CATAGORIES

SAMPLE CODING HIERARCHY

(XX___) = Sampling Catagory} 01 to 99
(__XX_) = Sampler Type} 01 to 99
(____X) = Sampler Usage} 1 to 9

(XX___) SAMPLING CATAGORIES

(01___) thru
(09___) - Electronic, Automatic/Remote, Water/Air Samplers

(10___) thru
(19___) - Mechanical & Manual Water/Air Grabs

(20___) thru
(29___) - Mechanical & Manual Sediment/Solids Grabs (includes Manual Slicing, Scraping, Shoveling, Scooping, etc.)

(30___) thru
(39___) - Mechanical Corers, Dredges, etc. (includes Large-scale Slicing, Scraping, etc.)

(40___) thru
(49___) - Nets, Hooks, Filters, Sieving, etc.

(50___) thru
(54___) - Accumulators (Amassing)

(55___) thru
(59___) - Electrical/Mechanical/Chemical Extractors & Sectioning (ie, Tissue Collection)

(60___) thru
(79___) - Electronic Sensors & Electrical Sample Collection Systems (Directly Operated)

(80___) thru
(89___) - Mechanical Gauges, Sensors, etc.

(90___) thru
(99___) - Observation, Photography, Visual Measurements, etc.

Code	Sampling Methods Description
86031	Manual horz/vert distance, by survey tape, carried
86032	Manual horz/vert distance, by survey tape, over time for velocity
86041	Manual horz/vert distance, by hip chain, carried
86061	Manual horz/vert distance, by pea level/survey rod, hand-held
86201	Manual horz/vert distance; by well probe, hand-lowered
87011	Mech thermometer, column, alcohol, range: -35 - 50 deg C, hand-held in situ
87012	Mech thermometer, column, alcohol, range: -35 - 50 deg C, in sample container
87051	Mech thermometer, column, mercury, range: -35 - 50 deg C, hand-held in situ
87052	Mech thermometer, column, mercury, range: -35 - 50 deg C, in sample container
87071	Mech thermometer, column, mercury, range: 0 - 50 deg C, hand-held in situ
87072	Mech thermometer, column, mercury, range: 0 - 50 deg C, in sample container
87200	Mech thermometer, dial
90011	Observations, storm/non-storm condition, estimated by runoff condition
90051	Observations, cloud cover, estimated between 0 -100% coverage
90101	Observations, tidal condition/height, visual estimate
90102	Observations, tidal condition/height, by tide chart
90151	Observations, transparency, visual estimate
90152	Observations, transparency, by 20-cm black-on-white secchi disk
94010	Manual counts, by counting frame, quadrant, 1-meter square
96000	Stream condition
98000	Photography

c: sampmeth.xls

Code	Sampling Methods Description
01011	ISCO autosampler, composite coll, by discharge (flow)
01012	ISCO autosampler, composite coll, by time
01013	ISCO autosampler, composite coll, by time, dependent on water height
01014	ISCO autosampler, composite coll, by time, dependent on storm event
01015	ISCO autosampler, composite coll, by time, dependent on pumping event
01021	ISCO autosampler, sequential coll, by discharge (flow)
01022	ISCO autosampler, sequential coll, by time
01023	ISCO autosampler, sequential coll, by time, dependent on water height
01024	ISCO autosampler, sequential coll, by time, dependent on storm event
01025	ISCO autosampler, sequential coll, by time, dependent on pumping event
02011	Manning autosampler, composite coll, by discharge (flow)
02012	Manning autosampler, composite coll, by time
02013	Manning autosampler, composite coll, by time, dependent on water height
02014	Manning autosampler, composite coll, by time, dependent on storm event
02015	Manning autosampler, composite coll, by time, dependent on pumping event
02021	Manning autosampler, sequential coll, by discharge (flow)
02022	Manning autosampler, sequential coll, by time
02023	Manning autosampler, sequential coll, by time, dependent on water height
02024	Manning autosampler, sequential coll, by time, dependent on storm event
02025	Manning autosampler, sequential coll, by time, dependent on pumping event
07010	PM-10 Particulate air sampler, high volume, by time (24 hr)
10011	Mechanical water grab, Niskin, shipboard, hydrowire cast
10012	Mechanical water grab, Niskins on CTD rosette
10030	Mechanical water grab, Nanson
10041	Mechanical water grab, Van Dorn, single cast, hand-tripped
10042	Mechanical water grab, Van Dorn, single cast, hand-tripped, 50/50 mix for chloa, phaeo, and nuts.
10043	Mechanical water grab, Van Dorn, single cast, hand-tripped, 50/50 mix for chloa and phaeo
10051	Mechanical water grab, Van Brenner, single cast, hand-tripped
10052	Mechanical water grab, Van Brenner, single cast, hand-tripped, 50/50 mix for chloa, phaeo, and nuts.
10053	Mechanical water grab, Van Brenner, single cast, hand-tripped, 50/50 mix for chloa and phaeo
11011	Manual water grab, individual bottles, dipped by hand
11021	Manual water grab, sample bucket w/o bottom drain, dipped by hand
11022	Manual water grab, sample bucket w/o bottom drain, hand-lowered
11031	Manual water grab, sample bucket with bottom drain, dipped by hand
11032	Manual water grab, sample bucket with bottom drain, hand-lowered
12011	Lysimeter, ceramic/PVC, 48-hr vacuum, hand-pumped
12020	Lysimeter, teflon
13011	Well sampling, submersible, stainless, electric pump
13012	Well sampling, stainless, gas-driven, portable bladder pump
13032	Well sampling, teflon, gas-driven, portable bladder pump

Code	Sampling Methods Description
62030	Single-parameter sensor, portable, DO
62040	Single-parameter sensor, portable, pH
65010	Electronic flow metering, hand-held, velocity
65020	Electronic flow metering, hand-held, electro-magnetic
65030	Electronic flow metering, hand-held, Pygmy
66000	Electronic flow metering, portable, other type
66012	Electronic flow metering, portable installation, sonic type, flow-actuated
66021	Electronic flow metering, portable installation, electro-magnetic, level-actuated
66022	Electronic flow metering, portable installation, electro-magnetic, flow-actuated
66031	Electronic flow metering, portable installation, bubbler, level-actuated
66032	Electronic flow metering, portable installation, bubbler, flow-actuated
67011	Elec flow metering, permanent install, SKADA, sonic type, level-actuated
67012	Elec flow metering, permanent install, SKADA, sonic type, flow-actuated
67021	Elec flow metering, permanent install, SKADA, electro-magnetic, level-actuated
67022	Elec flow metering, permanent install, SKADA, electro-magnetic, flow-actuated
67031	Elec flow metering, permanent install, SKADA, bubbler, level-actuated
67032	Elec flow metering, permanent install, SKADA, bubbler, flow-actuated
70011	Deployable current meter, Anderaa, self-contained, stationary vertical array
70012	Deployable current meter, Anderaa, self-contained, stationary platform mount
70013	Deployable current meter, Anderaa, self-contained, moble floating platform
76010	Electronic horz/vert distance & azimuth, Total Station
80011	Mech water-level gauges/rods, staff, mounted within channel
80012	Mech water-level gauges/rods, staff, mounted within channel, flow calculated
80021	Mech water-level gauges/rods, staff, mounted within pipeline
80022	Mech water-level gauges/rods, staff, mounted within pipeline, flow calculated
80211	Mech water-level gauges, weir, mounted within channel
80212	Mech water-level gauges, weir, mounted within channel, flow calculated
80221	Mech water-level gauges, weir, mounted within pipeline
80222	Mech water-level gauges, weir, mounted within pipeline, flow calculated
80411	Mech water-level gauges, crest, mounted within channel
80421	Mech water-level gauges, crest, mounted within pipeline
83011	Wind speed indicators, elec-mech anemometer, hand-held, facing wind
83020	Wind speed indicators, elec-mech anemometer, shipboard-mounted
85010	Bearing (direction) indicators, compass, hand-held
85020	Bearing (direction) indicators, compass, shipboard-mounted
85030	Bearing (direction) indicators, visual estimate
86011	Manual horzizontal distance, by pacing
86012	Manual horz/vert distance, by pacing, over time for velocity
86021	Manual horz/vert distance, by meter stick, hand-held
86022	Manual horz/vert distance, by meter stick, over time for velocity

SEDIMENT TYPE 7/29/85
(5-CHARACTER CODE FORMAT: XXXXX) DSS

SAMPLE CONSISTENCY

PRINCIPAL FRACTION (X----).

(CODE)
1--CLAY ((.0039MM)
2--SILT/MUD (.0039MM-.063MM)
3--SAND (.063MM-2MM)
4--GRAVEL (2MM-16MM)
5--PEBBLE/COBBLE(16MM-256MM)
6--BOULDERS ()256MM)

SECONDARY FRACTION (-X---)

(CODE) * = PHI SCALE
0--NO 2NDARY FRACTION
1--CLAY (*9)
2--SILT/MUD (*5,6,7,8)
3--SAND (*0,1,2,3,4)
4--GRAVEL (*-1,-2,-3)
5--PEBBLE/COBBLE (*-4,-5,-6,-7,)
6--BOULDERS (*-8)

PREDOMINANT SAMPLE DEBRIS (--X--)

(CODE)
N--NO DEBRIS
W--WOOD CHIPS
M--METAL FRAGMENTS
T--TUBE WORMS
P--PLANTS (MACROPHYTES)
S--SHELLS
C--COAL
O--OTHER MAN-MADE DEBRIS

PREDOMINANT SAMPLE COLOR (---X-)

(CODE)
1--BLACK
2--BROWN
3--GREY
4--GREEN
5--TAN

SAMPLE ODOR (----X)

(CODE)
0--ODORLESS
1--NATURAL, NON-SPECIFIC
2--SOLVENT/PETROLEUM SLIGHT
3--SOLVENT/PETROLEUM MODERATE
4--SOLVENT/PETROLEUM STRONG
5--SOLVENT/PETROLEUM OVERWHELMING
6--HYDROGEN SULFIDE SLIGHT
7--HYDROGEN SULFIDE MODERATE
8--HYDROGEN SULFIDE STRONG
9--HYDROGEN SULFIDE OVERWHELMING

APPENDIX B

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